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SCIENTIFIC MAN-POWER IN BRITAIN

THE Parliamentary and Scientific Committee has produced a useful report on "Universities and the Increase of Scientific Man-power", which is neither rigid nor excessively weighted by the statistical factor. The general tenor of the report of the Barlow Committee is endorsed, although the view is taken that the relative pre-war weakness of British economy in the application of scientific methods suggests aiming at less than an approximate doubling of our estimated pre-war scientific man-power. In setting a target of 100,000 qualified scientific workers by 1955, the Committee expresses the view that there is room for expansion of the industrial research associations, and refers also to defence research, medical and veterinary science and the Agricultural Advisory Service as likely to call for many more scientific men, apart from the probable increase in industrial requirements. It emphasizes the first-class importance of the question of qualifications, and that quality, as well as quantity, must always be kept in mind. Like *Planning*, in its broadsheet, "Britain's Need for Man-power", it presses for an early inquiry into the probable ultimate demand for each particular category of scientific worker, so as to avoid inducing young men and women into courses of study which do not lead to satisfying careers.

Probably the most important recommendation in this report is that such an inquiry should be set on foot forthwith, and it should engage the active attention of the Ministry of Labour as well as of the professional organisations and the university appointment boards. To achieve even the total of 90,000 qualified scientific workers recommended by the Barlow Committee will scarcely be possible by 1955 unless the output from the universities increases faster than the Barlow Committee proposes; but the Parliamentary and Scientific Committee accepts a doubling of the output as the most that can be asked of the universities in the immediate future. Moreover, it agrees with the Barlow Committee that the increase in the number of scientific graduates should be balanced by a substantial increase in the number of students studying the humanities; and it proceeds to discuss university expansion on the basis of doubling the entire university output of graduates.

The primary and most obstinate difficulty in such expansion is the provision of sufficient and well-qualified teaching and research staff. The Parliamentary and Scientific Committee believes that the present shortage of staff will restrict the expansion of universities until 1949–50, when it should be possible to double the annual intake; and that, at least in the sciences, with which the Barlow and the present reports are immediately concerned, it should be practicable to double the well-qualified academic staff during the next four years, bringing the present total of 4,000 university teachers to 8,000–10,000. The first step is, of course, to ensure that the staff expands at least as rapidly as the student population; and the report also emphasizes what has already been said in many earlier reports

with regard to adequate salaries, maintaining a proper balance of teaching and research time and generally making university teaching a sufficiently satisfying career to attract the right kind of people. It directs attention, moreover, to the importance of accommodation, both for teaching and for research, and to the need for the generous grant of priorities by the Government in these respects and also in the matter of hostel accommodation and the like.

So far as the distribution of the proposed expansion between different institutions is concerned, the Parliamentary and Scientific Committee fully endorses the recommendations of the Barlow Committee, but suggests further that difficulties in the expansion of the newer civic universities, where the major expansion must occur, might be overcome by migration of the university from the centre of a city to its outskirts. In London, it is thought there might with advantage be as many as four universities, and the Committee suggests decentralization or actual division, with a target figure of 25,000 students or more. At Oxford and Cambridge, an increase in the annual number of science students might be expected, for at Oxford in 1939 they formed only 10 per cent of the total; and apart from the immediate post-war 'bulge', these two universities might well contribute a total increase of 2,000 science students over the next five to ten years. While, however, some of the existing university colleges, such as Nottingham, should, in the Committee's opinion, now be raised to university status, and other university colleges such as Leicester and Hull should be fostered, the foundation of new universities is regarded as inexpedient, and likely to hinder rather than help the immediate expansion.

The changes visualized in this report would give as the maximum expansion over the next five years a total of 108,000 undergraduates. If the building programme involved is to be accelerated, it is important for the right type of information to be available to the appropriate Government departments in the right form, and the Parliamentary and Scientific Committee directs attention to the value of a schedule setting out the precise amount of accommodation required, faculty by faculty, throughout the country, with a cross-index against universities, expressed in a uniform and easily understood unit of measurement. Early provision of such a schedule would facilitate the integration of university requirements with the rest of the national demand for building labour and materials, and might assist in procuring the priorities which are the first and most urgent need. Incidentally, the need for providing the University Grants Committee with appropriate staff and secretariat is again stressed; and while the Parliamentary and Scientific Committee recognizes that the required expansion should proceed without any loss of independence on the part of the universities, it looks for much more positive action by the University Grants Committee. Not only should this Committee be strengthened, but also at the same time the Vice-Chancellors' Committee should be provided with an adequate permanent secretariat; there is also need for a general forum for the interchange of views between all the universities at all levels and in all the fields concerned, and comprising principals, administrative and teaching staff.

The report does not press quite so firmly for an active and consultative body, such as a universities council, as recommended in its earlier report; but the University Grants Committee, by implication at least, seems to be the body to be charged with the responsibility for planning university expansion. The cost of that expansion is put by the Parliamentary and Scientific Committee in the region of £100 millions for capital expenditure over the next ten years, and it suggests that an appropriate sum should be earmarked for the purpose by the Chancellor of the Exchequer, at least for five years, so as to facilitate planning with confidence. The annual cost of expansion is put at £10 millions, or a total expenditure of £30 millions annually on the universities, a figure which agrees with that given by the *Economist* last year; in particular, it is urged that, so far as possible, no young person of requisite ability should be prevented by financial considerations from participating in these increased facilities for university education.

The proposed expansion of the universities of Britain cannot, of course, be realized without a parallel expansion of the secondary schools; and important as is generous financial assistance from the Government, that alone will not suffice under present conditions. The highest priorities must also be given for the man-power and materials required for building the increased accommodation that expansion involves.

When we have provided the machinery for training the man-power required to meet the needs anticipated in the professions, in industry and in business during the next ten years or so, and have done something to ensure that the standards of management are such that unnecessary wastage is eliminated, there still remains the arrangements for recruitment, which are surveyed in some detail in the second part of the *Planning* broadsheet on "Britain's Need for Brain-power". Such arrangements should endeavour to secure recruits of the highest possible quality, the broad adjustment of supply to the demand, and a reasonable distribution of the most able men and women among the various callings. The latter objective may be the most important at a time of acute shortage of man-power, as without some system of priorities, bottle-necks may be created which hinder the further expansion of man-power; for example, if too many scientific workers are attracted into industry or the Government service, then the universities may be unable to expand their teaching and research staffs appropriately. All three alike involve energetic measures to provide advice and information about careers, to ensure financial assistance to those who, though suitable, would otherwise be unable to undertake the necessary training, to improve methods of selection, to secure that salaries and conditions are reasonably well balanced between the major callings, and to tap all sources of recruitment.

Implementation of the recommendations of the Hankey Committee on Higher Appointments would

place the relevant facts at the disposal of young people deciding on a career, although the schools, universities and professional institutions might also make important contributions. Methods of selection, however, are specially important at the present time. Upon their efficiency depends the success of a profession or organisation in obtaining the best recruits available, while upon their reputation for fairness depends to some extent the quality of the young men and women who come forward. *Planning* urges that a proportion of university scholarships should be awarded for outstanding personal qualities combined with good intelligence rather than for purely academic attainments, and that the scientific techniques of selection developed in the Services should be further explored and turned to account. The universities and other training institutions should give attention to the co-ordination of standards of selection, to avoid a situation in which variations in the ratio of applicants for vacancies may lead to one university accepting students of a standard rejected by another. Moreover, in this connexion there must be borne in mind the considerations brought to light in Sir Cyril Burt's study, "Intelligence and Fertility". If the present differential birth-rates are in fact not only lowering the level of innate general intelligence but even threatening to reduce by fifty per cent in the next half-century the number of children of scholarship ability in the schools, the selection of university students as well as the use of graduates will require even closer study by the universities as well as by professional bodies, industry and the Government.

Other factors noted by *Planning* indicate the many ramifications of the man-power problem, and no doubt they are receiving careful study by professional associations. To expand to the full the limited resources in Great Britain of trained man-power, and to ensure that it is reasonably distributed and used with the maximum economy, are matters which demand much more than Government initiative alone. The universities are concerned at both the beginning and end of any scheme, in that they must consider sources of supply, training and the placing of students; and throughout there must be the fullest co-operation with management in industry, commerce and departments of State.

VERNALIZATION AND PHOTOPERIODISM

Crop Production and Environment
By R. O. Whyte. Pp. 372+32 plates. (London: Faber and Faber, Ltd., 1946.) 25*s*. net.

THE scope of this book is much narrower than its title suggests, for it deals with only one aspect of crop production, and only two out of the whole complex of environmental factors. Its subject is the effect of temperature and of light on the 'development' of plants, defined by the author as "the progress towards reproduction by externally recognizable or invisible stages", as distinct from 'growth' in the sense of dry matter accumulation or increase in size. As the author points out, this separation of the two aspects of growth, in the wider sense, is open to criticism, though it may be justified by experimental convenience. 'Development' and growth are not independent, as is very obvious in agricultural practice, where the object of controlling 'development' is to increase 'growth' as measured by the harvested yield.

Developmental physiology was brought into prominence by the discovery of the phenomenon of photoperiodism by Garner and Allard, and of the process of vernalization by Lysenko. Garner and Allard showed that sexual reproduction can be attained by a plant only when it is exposed to a specifically favourable length of day. Lysenko and his colleagues followed up the work of Gassner, who found that winter forms of cereals differ from spring forms in that their flowering is dependent on exposure to low temperature. They showed that the low-temperature treatment was effective at a very early stage of germination, or even during the growth of the grains in the ear of the parent plant. Partially sprouted grains of winter forms, after a period of exposure to low temperature, behaved like spring forms when sown, and were, therefore, said to be vernalized.

These observations have been greatly extended during the past twenty-five years, the developmental physiology of many species has been investigated, and attempts have been made to determine the nature of the internal processes which control the course of development. Much of this work has been done in the U.S.S.R., and unfortunately its design and interpretation have been limited by an uncritical acceptance of Lysenko's theory of phasic development. This postulates that the development of an annual plant proceeds by a sequence of irreversible stages, each of which must be completed before the next can begin, and that different phases require different environmental conditions for their completion. The Russian workers have set out to identify these hypothetical phases, and to determine their duration and environmental requirements, rather than to make an unbiased analysis of the effects of environment on development. The author of this book has not attempted to interpret their results on a broader basis, although he points out that the work of Gregory and Purvis, and others, has provided convincing evidence of the incorrectness of the theory. Nevertheless, he has performed a useful service by abstracting the Russian literature and making it more accessible to English readers.

An account of the effects of temperature and of the duration and intensity of light on development is given in the first eight chapters of the book. The next four chapters discuss changes in the physiological processes of the plant which accompany vernalization, or induction of flowering by adjustment of the photoperiod. Although variation in several physiological attributes, including the carbon – nitrogen ratio, respiration and enzymatic activity, occurs in association with the change from a vegetative to a reproductive state, it is still not clear which, if any, of these variations are causal, and which consequential. The existence of specific flower-forming substances or hormones is suggested by experiments which show, for example, that photo-induction can be transmitted from a single leaf or part of a leaf to the rest of a plant held in a photoperiod unfavourable for flowering, or across grafts, even when union of the cut surfaces is incomplete, but no such hormone has yet been isolated. Hormones have also been

invoked to explain the vernalization effect, but the suggestion that the hastening of development is caused by an accumulation of auxin in the embryo during low-temperature treatment has recently been shown to be erroneous. Further work on these lines is very desirable, for until the physiological nature of developmental response is known, it will be difficult to systematize the great mass of empirical data which has accumulated.

The remainder of the book discusses the application of developmental physiology to problems in the geographical distribution of plants, to plant breeding, and to agriculture and horticulture. Direct control of the development of glasshouse crops is fairly easy, and is already being practised; but there seems to be little scope for this in agriculture, because the only environmental factors readily controllable in the field are the supplies of nutrients and water. However, as the author points out, a knowledge of the developmental requirements of crops should assist in the breeding of varieties which will attain the required state of development in whatever environment the crop is to be grown. Treatments involving critical manipulations, such as vernalization, may be of temporary value when the area of cultivation of a crop is being extended, but it seems that they are likely to go out of use when varieties suited to the new conditions become available. This, apparently, is already happening to the vernalization method in the U.S.S.R.

It is regrettable that the style in which this book is written does not do justice to the interest and importance of its subject. Most of the book consists of a succession of abstracts of published papers, often with little obvious connexion between one paragraph and the next. Consequently, the exposition lacks a co-ordinated plan and systematic development. Some of the abstracts include statements which are not relevant to the subject under discussion, so that the reader is misled into seeking a significance where none exists. The conclusions are sometimes so condensed as to be either unintelligible or platitudinous. Another objectionable feature is that many of the fifty-three figures are not referred to in the text, or are inserted at places remote from the text-reference. The legends attached to the figures are rarely sufficiently detailed to make the figures self-explanatory, or to show their significance in relation to the text.

D. J. Watson

COLOUR VISION

Researches on Normal and Defective Colour Vision
By W. D. Wright. Pp. xvi+383. (London: Henry Kimpton, 1946.) 36*s*. net.

THIS book is primarily an account of the researches on colour vision carried out by the author and various co-workers in the technical optics department of the Imperial College of Science and Technology over a period of twenty years. Most of the work has been published, from time to time, as papers in scientific journals or special reports of the Medical Research Council; but in this book it is re-written as a logically connected story. This adds much to its value, not only by placing the various investigations in their proper perspective relative to each other, but also by collecting between one pair of covers material for which the student has hitherto had to search through many channels.

When Dr. Wright initiated his programme of work on colour vision twenty years ago, he had a very open field in which the problem was not to find something worth investigating but to decide where to start. Not that the field was unexplored. On the contrary, almost any problem on colour vision which one could formulate had already been investigated—generally by many workers—and had considerable literature devoted to it; but, despite this, there was scarcely one to which a satisfactory solution had at that time been found. This was undoubtedly due not to the lack of competent theorists but to the ill-defined and often conflicting data provided by the experimenters. Vision, like other so-called psychophysical subjects, is of interest to the physicist, physiologist and psychologist. All three have contributed to its investigation and discussion, each bringing different qualifications to the task. In many respects this three-directional approach has been beneficial: in fact, it is clearly necessary to a proper understanding of any sensory problem; but in one important respect it has made matters difficult. Much of the experimental work reported in the literature has been carried out by investigators who have lacked the competence in physical experimentation necessary to produce accurate results of clearly defined significance, and because of this the literature contains a great mass of apparently conflicting information which provides a headache for the critical theorist and a plentiful choice of alternative inspirations for the uncritical.

The value of the work of Wright and his colleagues lies in the fact that it is an attempt to re-survey the measurable aspects of visual behaviour under properly controlled experimental conditions—to provide a body of factual information which, however difficult it may still be to correlate and explain by a simple and all-embracing theory, can be stated unambiguously, and with all relevant detail, in clearly defined terms. Considerable as their success has been, their task is by no means completed, and Dr. Wright, in his preface, still describes the subject as one in which "so little is known about so much". The description is just, even at the present day; but the researches described in this book have undoubtedly helped to make the little considerably more than it was twenty years ago.

The book is divided into eight parts, of which the first consists of two introductory chapters dealing respectively with the physiological structure of the visual organ and with visual perception in general. The inclusion of these chapters is useful, as they treat their subject-matter in sufficient detail to fit the general reader for intelligent perusal of the later chapters without a troublesome amount of reference to other works. Part II is devoted to describing and explaining the operation of the author's trichromatic colorimeter, which, on account of its flexibility, can be adapted to a variety of purposes and is the basic instrument with which a considerable proportion of the researches have been carried out. Part III deals with luminosity measurements under various conditions of field size, field brightness and retinal region; Part IV with problems of colour mixture; Part V with problems of visual discrimination; Part VI with problems of adaptation; Part VII with defective colour vision; Part VIII with the interpretation of colour vision phenomena in terms of fundamental response curves. This skeleton summary of the contents, while it gives no idea of the amount and variety of the work recorded in the thirty chapters,

will suffice to indicate the extent of the field which has been covered. The discussions of principles which occur throughout the book, and the theoretical explanations generally, are clearly written and should be easily followed by the average reader. For example, in explaining the significance of the spectral luminosity curve, the author manages in a few easy paragraphs to make clear the fundamental difference between the information provided by this curve and by the apparently similar spectral sensitivity curve of a purely physical light-sensitive apparatus such as a photocell. Failure to realize this difference has been the cause of much false reasoning by writers on the psychological implications of experiments on relative luminosities. His account of the principles of trichromatic colour measurement is based on a purely factual approach which strips it of all superfluous physiological or psychological assumptions.

Where so much is good it seems ungracious to complain, but the clarity of thought and diction which characterizes so much of the book seems, to the reviewer at least, to be missing from Chapter 23, on the measurement of subjective brightness. Discussion of the matter would be out of place here; but I am unable to discover what Dr. Wright means by subjective brightness—which he seems to identify with apparent brightness—or what he considers the 'brill' scale measures. The assumption that equality of contrast at different brightness-levels corresponds to equal differences of 'apparent' or 'subjective' brightness seems to underlie the treatment. This has no more justification than many of the other commonly made assumptions about relations between stimuli and sensations which are so ably refuted elsewhere in the book. This chapter is, however, a comparatively trivial interpolation in a volume which must be welcomed as a major contribution to the literature of colour vision. J. G.

WAR AND NATIONS

Human Nature, War and Society

By Dr. John Cohen. (Thinker's Library, No. 112.) Pp. x+193. (London: Watts and Co., Ltd., 1946.) 2*s.* 6*d.* net.

The Idea of Nationalism

A Study in its Origins and Background. By Prof. Hans Kohn. Pp. xiii+735. (New York: The Macmillan Company, 1946.) 36*s.* net.

The Decline of Liberalism as an Ideology

With Particular Reference to German Politico-Legal Thought. By John H. Hallowell. (International Library of Sociology and Social Reconstruction.) Pp. xiii+141. (London: Kegan Paul and Co., Ltd., 1946.) 12*s.* 6*d.* net.

German Youth

Bond or Free. By Prof. Howard Becker. (International Library of Sociology and Social Reconstruction.) Pp. xiii+286. (London: Kegan Paul and Co., Ltd., 1946.) 18*s.* net.

DR. J. COHEN'S stimulating pamphlet, "Human Nature, War and Society", does not claim to present more than a provisional hypothesis of the causes of war, and is in fact concerned rather with negative than with positive conclusions. We have long been familiar with the easy generalizations that evade the whole issue by finding the causes of war variously in human nature, armaments, biological necessity, animal aggressiveness or primitive savagery, and Dr. Cohen adduces ample evidence to dispose of these shirkings of the problem. "Human nature," he says, "is much maligned. It is unjustly held responsible for war and many other troubles which are really due to neglect or ignorance", and he makes a strong plea for 'scientific inquiry' to dispel ignorance, and by revealing the causes of war to render easier its control. But he has little that is constructive to offer. His thesis that war is the mark of civilized rather than of primitive societies is sound enough, but does not get us far, and he accepts rather too readily the common view that nationalism is a cause of war; it can equally be claimed to be a result of it. The remedy for war he finds in education and a 'world order' built in its earlier stages on such functional organisations as U.N.R.R.A. and F.A.O. (both of which, in spite of what he says on p. 176, are surely 'inter-national' rather than 'supra-national'). The choice of U.N.R.R.A. as an example was, perhaps, not altogether a happy one in view of recent events, and throughout his recommendations Dr. Cohen is impatient of current difficulties. There is more in Lord Beveridge's proposals, which he criticizes on p. 163, than he is prepared to recognize, at least at the present stage of world development. Nevertheless, Dr. Cohen has done useful work in sweeping away common fallacies and in directing attention to the need for that 'scientific' investigation of the causes of war that is the task of the historian. Scarcely less valuable, perhaps, would be a study of the wars that were prevented—an aspect of the subject that seems to have been overlooked.

Prof. H. Kohn has applied to the related problem of nationalism the 'scientific' treatment that Dr. Cohen advocates. "The Idea of Nationalism" is a solid compendium of information about the origins and development of the spirit of nationalism up to the time of the French Revolution, and, true to the American academic tradition, is heavily weighted with notes and references, which account for no less than one fifth of its total size. In effect, the work is a survey of the development of the European States system, and of much of the commentary of political thinkers at every stage of its growth. Judgments are sometimes summary, as in the statement on p. 132 that Francis I of France "succeeded in destroying the two pillars of medieval society—the feudal nobility and the Church", which says both too much and too little; but tribute must be paid to Prof. Kohn's industry and width of reading. The present volume is only preparatory, however: the real value of the study can scarcely be estimated until the next volume, dealing with nationalism in action, appears. For the present, we can but note Prof. Kohn's view that "nationalities are the product of the historical development of society"—an answer, if one were needed, to racial myths—and that they "defy exact definition". It would seem, therefore, that in their present form they are scarcely likely to prove permanent institutions, a view which Dr. Cohen will welcome.

Prof. J. H. Hallowell's "Decline of Liberalism as an Ideology" and Prof. H. Becker's "German Youth: Bond or Free" are recent additions to an unequal series. Prof. Hallowell is concerned with the decline of Liberalism in Germany as reflected in politico-legal thought; and in a survey of the writings of German thinkers throughout the nineteenth century he shows how Liberalism degenerated in academic theorizing, which gradually transformed the Liberal concept of

the *Rechtsstaat* into an instrument of absolutism, and thereby prepared the way for the acceptance of Nazism by men who should have known better. The book presents a careful analysis of material which is necessary for the understanding of Nazi ideology; but the picture it gives is only a partial one. More needs to be said of the place of this politico-legal thought in the development of modern Germany and of the influence it exerted, before its significance in the tragic story can be correctly estimated.

Prof. Becker has taken another aspect of German life, the youth movements, and his book is claimed by the publisher to be "invaluable to all those concerned with the re-education of Germany". It is to be hoped, however, that the re-educators will know more about Germany and her past than this not very revealing work can tell them. A good deal has already been published about the youth movements that preceded Hitler's; Prof. Becker has little fresh light to throw on them.

MAURICE BRUCE

EXPLORERS OF CANADA

The Discovery of Canada

By Lawrence J. Burpee. Pp. x+280. (Toronto: The Macmillan Co. of Canada, Ltd., 1944.) 12*s.* 6*d.* net.

DR. L. J. BURPEE was well known as an authority on the exploration of Canada, and in this work naturally draws on his own researches. But the book is much more than repetition. It covers a long period, from the rather vague discoveries of the Norsemen to the voyage of Sergeant Larsen through the North-West Passage in 1940–42. It includes biographical notes on one hundred explorers and a detailed bibliography. A useful outline map forms the end papers.

The author's aim is to "let the story of the discovery of Canada tell itself", and this he does by introducing a large number of extracts from the writings of the explorers. These add greatly to the value of the narrative, though some are introduced for their personal appeal rather than for the light they throw on the progress of discovery.

The method adopted is to divide the country into four main areas—the Valley of the St. Lawrence, Hudson Bay and the Plains, the Pacific Slope, and the Far North—and to complete the story of each part. This has some disadvantages. We follow Mackenzie to the Pacific coast before we read of his earlier journey to the north, and we read in two separate sections of the work of David Thompson. There is, however, no easy way of dealing with such a large body of material, and Dr. Burpee does indicate, in his last chapter, some of the broad features which marked the progress of discovery. Of the early explorers, Dr. Burpee has little fresh to say, and wisely refrains from joining in controversy about landfalls of the Norsemen and John Cabot. But he does scant justice to Sebastian Cabot, for although he includes Dr. Williamson's classical study in his bibliography he makes no reference to the voyage of 1508–9. On evidence available at present there seems to be no reason to doubt that Sebastian discovered Hudson Bay on that voyage. Nor is Dr. Burpee entirely happy in his references to Drake and to Cook. Drake is said to have "rounded the Horn in 1578". He may have seen the southern end of South America, but he had sailed through Magellan's Strait and been driven south by storms. As, however, he never saw any part of Canada—and this may be said of several explorers who are included in the book—the error is of small importance. As for Cook, he is described as having "explored the north-west coast of North America from Nootka Sound, in Vancouver Island, to Alaska". Actually his instructions, which he carried out faithfully, were to make for New Albion, the land of Drake's discovery, and then sail along the coast without delaying to explore it until he reached 60° N., that is, in the modern Alaska. Hearne had shown, as Dr. Burpee points out, that a passage in any lower latitude was unlikely to be found, and Cook's business was to find a passage rather than to explore a coastline. It was Vancouver, as Dr. Burpee shows, who was the real explorer of this coast, and it is a pity that more space has not been given to his accurate, detailed, but often forgotten survey.

The publishers claim this as Dr. Burpee's "greatest contribution to Canadian history". We doubt if the author would have shared this view. None the less, his book is full of learning and of human interest and can be read with profit and with pleasure by the serious student and by the general reader.

J. N. L. BAKER

BIOLOGY OF SEX HORMONES

Biological Actions of Sex Hormones

By Dr. Harold Burrows. Pp. x+514. (Cambridge: At the University Press, 1945.) 42*s.* net.

DR. H. BURROWS' volume provides a comprehensive summary of literature on the sex-hormones up to the period 1941–42. It is divided into six parts, which deal, respectively, with the gonadotrophic factors of the pituitary; the gonadal hormones in general; the androgens; the œstrogens; the progestational hormones; and the sex hormones of the adrenal cortex. The author has not excluded any material of importance, and because of the length of the book and his method of presentation, it has necessarily assumed more the character of a summary of what has been written on different topics than a review, the specific purpose of which would be to demonstrate the most fruitful trends of current research and a general synthesis of the subject. As Dr. Burrows himself states, his purpose was to produce "a co-ordinated summary of experimental enquiries" carried out in the laboratory. In this he has undoubtedly succeeded, even though one regrets that he has stopped short of providing the reader with his own general, or special, conclusions about the matters which he has treated.

The War has receded far enough for one to be aware of the debt that is owed to those who have made it possible for others to recapture the thread of fundamental science with speed and ease. The war years not only considerably slowed down the rate of basic research, by interpolating other more practical issues into the everyday life of the man of science; they also diluted the flow of interest in many fields of science, with the result that before resuming work, a great deal has to be done by the individual worker in reconcentrating his sphere of interest. This difficulty is particularly great in the more actively growing fields of science, and all endocrinologists will therefore owe a major debt of gratitude to Dr. Burrows for his painstaking service and solid achievement in pulling together the literature of the subject in so useful a form.

NATIONAL RESEARCH LABORATORIES OF INDIA

INTRODUCTION

By Sir SHANTI BHATNAGAR, O.B.E., F.R.S.
Director, Scientific and Industrial Research, India

THE importance of scientific research and of the application of scientific knowledge to all national reconstruction activities has been fully realized in India in recent years. In order to organise co-ordinated research in the several sciences fundamental to the welfare and progress of the country, it was considered desirable to establish laboratories in which scientific and industrial research could be carried out on a sufficiently large scale commensurate with our future industrial potential, and a proposal to this effect was first initiated by the Director of Scientific and Industrial Research in September 1941.

It will, perhaps, not be out of place to give here a brief account of the early work of the Council of Scientific and Industrial Research, as the present plans for the Laboratories have a direct bearing on it. It may be recalled that a Board of Scientific and Industrial Research was set up by the Government of India in 1940, and this was followed by the setting up of the Council of Scientific and Industrial Research in 1942 to control and co-ordinate the activities of the Board and of the newly created Industrial Research Utilization Committee. This was the first concrete step taken by the Government towards placing industrial research on its feet in India, though the immediate need arose mostly out of demands made by the War. The War provided an effective stimulus to the activities of the Council, which steadily increased even with the limited facilities available, since any large expansion scheme was ruled out by difficulties in obtaining building materials, laboratory equipment, services of experts, etc. The initial experience during the war-period, however, served the useful purpose of bringing to light the inadequacy of the existing organisation and thereby focusing public attention on the necessity for expanding the facilities available for research as an important national problem.

Accordingly, in the following year, the Council approached the Government of India with a post-war plan for the establishment of five national laboratories and research institutions; namely, a National Physical Laboratory, a National Chemical Laboratory, a National Metallurgical Laboratory, a Central Glass and Ceramic Research Institute, and a Fuel Research Institute. The scheme was formally approved by the Government, and active planning work for the five laboratories was started soon after, by the setting up of expert committees for drawing up detailed plans and estimates for each of the laboratories. The Government announced a capital grant of Rs. 1 crore for the establishment of these laboratories, and also allotted a spacious site of more than sixty acres of land in New Delhi for the location of one of the national laboratories. Considerable public interest was evinced in the Council's scheme, and several industrialists came forward with donations towards the cost. The House of Tatas gave Rs. 20 lacs towards two of the laboratories—the National Chemical Laboratory, Rs. 8·3 lacs, and the National Metallurgical Laboratory, Rs. 11·7 lacs. The Indian Steel and Wire Products, Ltd., gave Rs. 1 lac, and the late Mr. D. P. Khaitan and the Indian Metallurgical Association gave Rs. 25,000 and Rs. 10,000 respectively. A prominent landlord, the Raja of Jharia, made a gift of 100 acres of land in Dhanbad —the heart of the coal-fields area—for the location of the Fuel Research Institute.

In planning the National Laboratories, the committees responsible have been fully alive to the immediate needs, and have also tried to meet future requirements by drawing up both short- and long-term programmes of work for each Laboratory. When completed, the Laboratories will cover all aspects of research in their respective fields, and will have semi-process or pilot-plant facilities for determining the value of the investigations to industry.

Standardization is another aspect of work which has not hitherto received sufficient attention in India. The Indian Standards Institution, which has just recently been established, will require considerable scientific assistance in its various technical committees, and the co-operation of the National Laboratories will go a long way towards establishing industrial standards suitable for the needs of the country. In addition, the National Physical Laboratory will have the custody of the fundamental national standards of mass and length.

The subject of fundamental versus applied research has been recently discussed in many quarters. But research can scarcely be divided into water-tight compartments: such division is a purely scholastic distinction which ignores how scientific research develops. What is fundamental to-day may become very much of applied research in a very short while. In actual practice, both the theoretical and practical aspects of science have progressed by an intimate interplay. Any artificial separation will be either theoretically unsound or practically unworkable, and if enforced will render theory arid and practice a petrified routine. It is by the interchange of thought and work that the most fruitful results have emerged. The part which fundamental as well as applied research is likely to play in future developments in India has been fully recognized by the Planning Committees of the various National Laboratories. The scope of work in each Laboratory could, perhaps, be best described to be of "the form of a continuous spectrum, at one end of which research work of the purest academic type and of the highest quality is carried out and at the other, the technical development of processes and equipment proceeds by stages".

One aspect of fundamental research work which can scarcely be neglected in India is that which requires specialized large-scale laboratories. During recent years, and particularly during the Second World War, organisation of scientific work has undergone vast changes. Not only does some of the present type of work require large-scale specialized organisations well outside the scope of university work, but also expenditure of money running into millions which can only be justified if diversified, co-ordinated and regulated application and professional continuity of work are guaranteed. This is not usually possible in the universities, where teaching and research necessarily go hand in hand and are essentially preparatory. Fundamental research is fast becoming a huge organised industry in itself, and must be planned as such.

It is necessary to stress here the important fact that these National Laboratories are not intended to supplant but to supplement the work of individual

or collective industrial concerns or universities in respect of research. They will undertake work of the kind that does not fall ordinarily within the scope of industries. Their approach to industrial problems will be from a broad national point of view, rather than from the narrow outlook of a particular industry. The Laboratories will be in a better position to employ suitable talent and to try alternative approaches to problems simultaneously, without being restricted by any ideas of immediate financial gains. As a general rule, problems which bear on wider social and economic aspects than any individual industry could be concerned with are of necessity subjects of State scientific research, and it is in this spirit that the Laboratories will fulfil their functions.

In concluding this introduction, I may quote the words of Pandit Jawaharlal Nehru when laying the foundation-stone of the National Physical Laboratory: "when I look at the picture of new India that is emerging, I feel sorry that I may not be there to see it in its full glory; nevertheless, it is glory enough to take part in the building of it".

THE NATIONAL PHYSICAL LABORATORY OF INDIA

By Dr. K. N. MATHUR
Assistant Director (Planning), National Physical Laboratory of India

THE National Physical Laboratory of India, the foundation-stone of which was laid at Delhi on January 4, 1947, by Pandit Jawaharlal Nehru in the presence of a distinguished gathering of Indian and foreign men of science, including Sir Charles Darwin, director of the National Physical Laboratory, Teddington, and Sir Harold Spencer Jones, Astronomer Royal, is expected to fill a wide gap in the scientific and industrial organisation of India. At present there is no well-equipped laboratory in India which undertakes standards work, nor does India possess any standards of length or mass which could claim statutory acceptance or which could be reproduced with scientific precision for the use of industry. The foremost function of the new Laboratory will be, therefore, the maintenance of fundamental and derived standards and the undertaking of research with the view of achieving a high degree of accuracy in the measurement and duplication of these standards. This will mean in practice that the Laboratory will have to undertake regular intercomparisons between its standards and those of other countries, which is the accepted method of all of the standards laboratories of the world.

Besides the fundamental standards of length, mass and time, there are direct derivatives of these, such as area, volume, density, velocity, etc., which have numerous industrial applications. In addition, scientific work as well as industry requires standards for a large number of other units, which only indirectly depend upon the fundamental standards, and the realization of which in practice requires scientific work of the highest precision. Some of the most important of these are the International Temperature Scale, over a wide range of temperatures; specific heats; conductivity; colour standards; electrical units such as the volt, ampere, ohm; standards of inductances and capacity; standard radio- and audio-frequencies; standards of luminous flux, etc. The great industrial expansion envisaged in the present plans of the Government of India will place a special responsibility on the Laboratory. This aspect of the Laboratory's work was emphasized by the Hon. Dr. John Matthai, Minister for Industries and Supplies, who is also the president of the Council of Scientific and Industrial Research, at the ceremony of laying the foundation stone of the Laboratory.

Fig. 1. Architect's drawing of the National Physical Laboratory, India

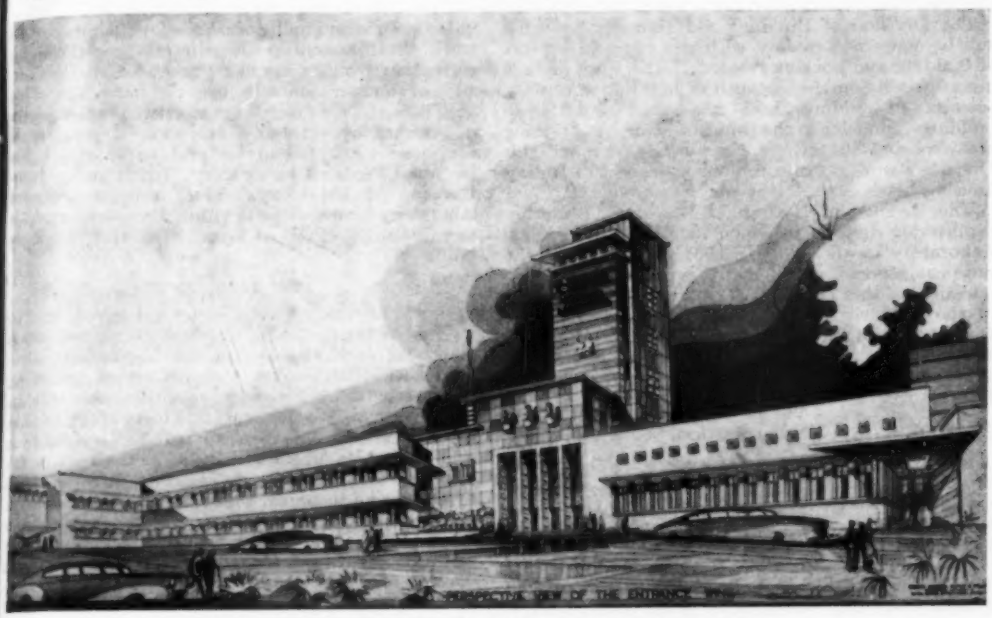

Fig. 2. Entrance wing of the National Physical Laboratory, India

Scheme for the Laboratory

A comprehensive scheme detailing the scope, functions, organisation, staff, etc., for the Laboratory was drawn up by a Planning Committee, presided over by Sir Ghulam Mohammad, and including some of the best-known Indian men of science, and has been published as a "Plan for a National Physical Laboratory for India". This report, which was drawn up after consultations with the National Physical Laboratory, Teddington, and the National Bureau of Standards, Washington, has been accepted by the Council of Scientific and Industrial Research, and forms the basis on which the blue-prints of the Laboratory have been drawn.

Divisions of the Laboratory

According to the Committee's recommendations, the work of the Laboratory will be carried on through nine Divisions, namely, (1) Weights and Measures; (2) Applied Mechanics and Materials; (3) Heat and Power; (4) Optics; (5) Electricity; (6) Electronics and Sound; (7) Building and Housing Research; (8) Hydraulics Research; and (9) Analytical Chemistry. In addition to the above scientific divisions, the Laboratory will have (*a*) a central library with a section dealing with research information for industry, (*b*) central workshops, including glass-blowing and -working shops, (*c*) general administration.

The Division of Weights and Measures will undertake all the metrological work of the Laboratory and will have the custody of the standards of mass and length. It will have the responsibility for supplying sub-standards to other testing institutions. Standardization and checking of gauges, tapes, and chains, standard screws, hydrometers, barometers, volumetric glassware, all fall within its scope. This Division will also deal with the checking of watches and chronometers, and will maintain standard time-keeping gear.

The Division of Applied Mechanics and Materials will be concerned with all problems of interest to engineers—elastic constants and the behaviour of materials under varying conditions of temperature and pressure, vibration and fatigue tests on materials under varying strains and with different types of loads, creep in metals, fluid friction, lubrication, etc.

The Division of Heat and Power will be responsible for all heat measurement and power development work. Testing of thermometers and pyrometers will be an important part of the work of this Division. Power development work will include heat engines, turbines, automobile and aero-engines, jet- and rocket-propulsion engines. Among other subjects which will be dealt with in this Division are low-temperature research, cold-storage problems and refrigeration.

The optical work of the Laboratory, including standardization of optical instruments, testing of lenses and binoculars, standardization of light sources, photometry and testing of lamps will fall within the scope of the Division of Optics.

It is proposed to subdivide the Electricity Division of the Laboratory into three sections dealing with (*a*) Electrical Standards, (*b*) Electro-technics, and (*c*) X-rays and Radiology. The electro-technics section will include also high-voltage tests. Standardization of radioactive sources, radioactive substances and their radiations will be included under section (*c*).

A very important Division of the Laboratory will be that of Electronics and Sound, which will include all aspects of electronic work, including electron microscopy. Investigations on the ionosphere and troposphere, research on micro-waves and development of radar, nature of atmospherics, industrial electronics, etc., are some of the other subjects to be included in this Division. The Sound section will cover all aspects of acoustical measurements and electro-acoustics, including properties of sound-insulating materials.

The Division of Building and Housing Research will be concerned mainly with the physical aspects of building and housing research. This may include investigations on the strength of building materials, acoustics of buildings, heat- and sound-insulation of buildings. Housing in the tropics and air-conditioning are expected to form an important part of this Division's work, as research on this aspect of India's housing needs is most urgently required.

The Division of Hydraulics Research is another engineering division in which the National Physical Laboratory's work will be concerned mainly with the physical aspects of the many problems. The importance of this Division will be very great in view of the large river development schemes which the Government of India is to launch very soon.

The Division of Analytical Chemistry will undertake analytical work for all the Divisions of the Laboratory.

Standardization

A very important aspect of work which has not so far received sufficient attention in India is that of industrial standardization. But with the recent inauguration of the Indian Standards Institution, India, it is hoped, will develop its own industrial standards in accordance with its special requirements. The National Physical Laboratory, it is expected, will be frequently called upon to assist the work of standardization by providing trained personnel and facilities for investigation by technical committees of the Standards Institution. The Council of Scientific and Industrial Research, it may be noted here, has been associated actively with the setting up of the Institution and was represented at the British Commonwealth Standards Conference and the International Conference on Standardization held in London in October last.

Location of the Laboratory

The question of the location of the Laboratory for a vast country like India is a very important one. The Planning Committee examined this question with great care, and made out an overwhelming case in favour of locating the Laboratory at the headquarters of the Central Government. It was realized that in any new constitution which India may have, the importance of contact between science and State will be even greater. Delhi has, in addition, a number of scientific departments of the Government of India, and close contact between them and the National Physical Laboratory will be mutually beneficial. In New Delhi, the Laboratory will be situated on a spacious site of more than sixty-six acres in close proximity to one of India's largest centres for agricultural research.

Very careful thought has been given to the design and lay-out of buildings for the Laboratory. Air-conditioning will be carried out practically throughout the entire Laboratory, and all precautions will be taken to eliminate dust. Since the great problem in India is to exclude heat from buildings as much as possible, the main wings of the Laboratory will run east and west, which will permit the use of natural light through north-facing windows without direct sunlight coming in. Provision is being made for a large lecture theatre and several seminar rooms. In addition to the central workshops, which will be equipped with the best and latest precision machinery, the several Divisions of the Laboratory will be provided with individual workshops for their day-to-day work. Staff amenities like cafeteria, social club and recreation grounds are being provided, as the necessity of human contacts between members of the staff is being constantly kept in view. On the question of internal lay-out and choice of apparatus, we had the benefit of the advice and experience of the National Physical Laboratory, Teddington. In the Division of Metrology, where accurate control of laboratory temperature is vitally necessary, the plans have been discussed at length with the Teddington staff.

Staff and Finance

The Laboratory will be under a director, who will be assisted with nine assistant directors—one in charge of each Division of the Laboratory. Each Division will have its complement of senior and junior scientific officers and scientific assistants, and for a start a scientific staff of ninety-eight has been recommended. The director will be assisted by an administrative officer to look after the routine non-technical work, and by an assistant director to look after routine technical work.

The capital cost of the Laboratory is estimated at four million rupees (£300,000), and a recurring grant of one million rupees (£75,000) annually is recommended for the first five years.

Money for the capital costs of the Laboratory has already been made available by the Government of India, and construction of the Laboratory is commencing very shortly.

NUCLEAR DISINTEGRATIONS PRODUCED BY SLOW CHARGED PARTICLES OF SMALL MASS

By Dr. G. P. S. OCCHIALINI
AND
Dr. C. F. POWELL
H. H. Wills Physical Laboratory, University of Bristol

IN studying photographic plates exposed to the cosmic rays, we have found a number of multiple disintegrations each of which appears to have been produced by the entry of a slow charged particle into a nucleus. Mosaics of photomicrographs of three of these events are given in Figs. 1, 2 and 3. The edges of the individual photographs have not been trimmed so that the components of the mosaics can be distinguished. Three grains of a track in Fig. 1, indicated by three arrows, which were out of focus in the original negatives, have been blackened with ink, but the photographs are otherwise completely unretouched.

It will be seen from Fig. 1 that, associated with the 'star', there is one track, marked *m*, which shows frequent changes in direction. The points of scattering are most frequent near the centre of the 'star', and become progressively fewer in moving away from it along the trajectory. This behaviour suggests that the particle approached the disintegrating nucleus. The conclusion receives additional support from the observation that the number of grains per unit length of the track, which can be taken as a measure of the ionization produced by the particle, is greatest

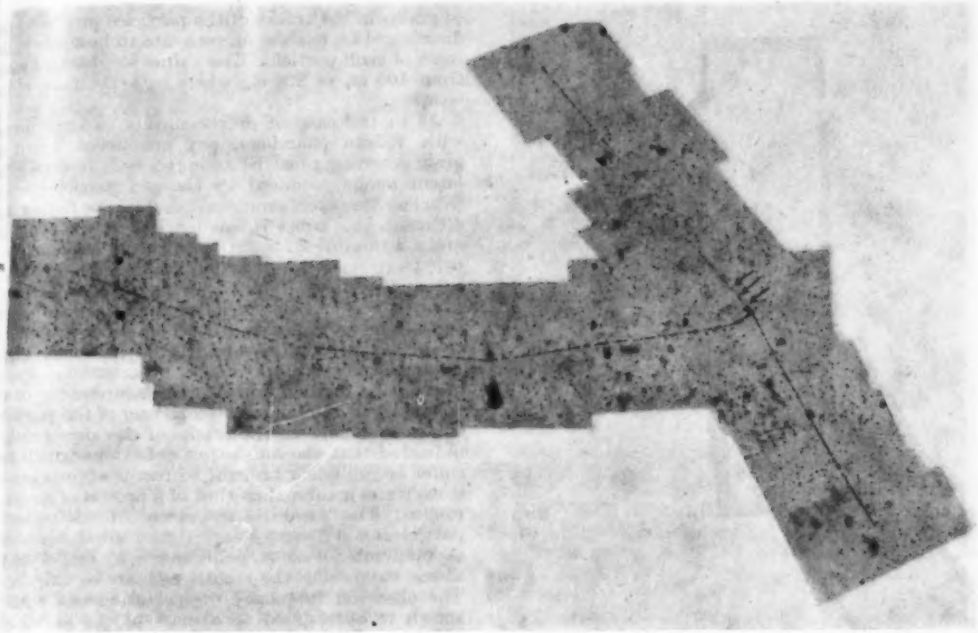

Fig. 1. COOKE × 45 'FLUORITE' OBJECTIVE, × 10 EYE-PIECE, WITH LEITZ PHOTOMICROGRAPHIC ATTACHMENT. C2 EMULSION LOADED WITH LITHIUM

The tracks of three disintegration particles can be distinguished, but only the particle of short-range remains in the emulsion

in the immediate neighbourhood of the disintegrating nucleus and becomes less as we recede from it.

We have now observed six of these events among a total of eight hundred stars. The probability, in any one case, that a charged particle, unrelated to the star, has, by chance, come to the end of its range within 1 micron of the disintegrating nucleus, is less than 1 in 10^6. We must therefore conclude that the particle entered the nucleus and produced a disintegration with the emission of heavy particles. Similar conclusions can be drawn from an inspection of the other photographs in Figs. 2 and 3.

The characteristics of the tracks which allow us to infer the direction of motion of the particles also lead to the conclusion that the particles were either at the end of their range or very near it when they entered the nucleus. In all cases the particles enter the emulsion from the glass or at the surface.

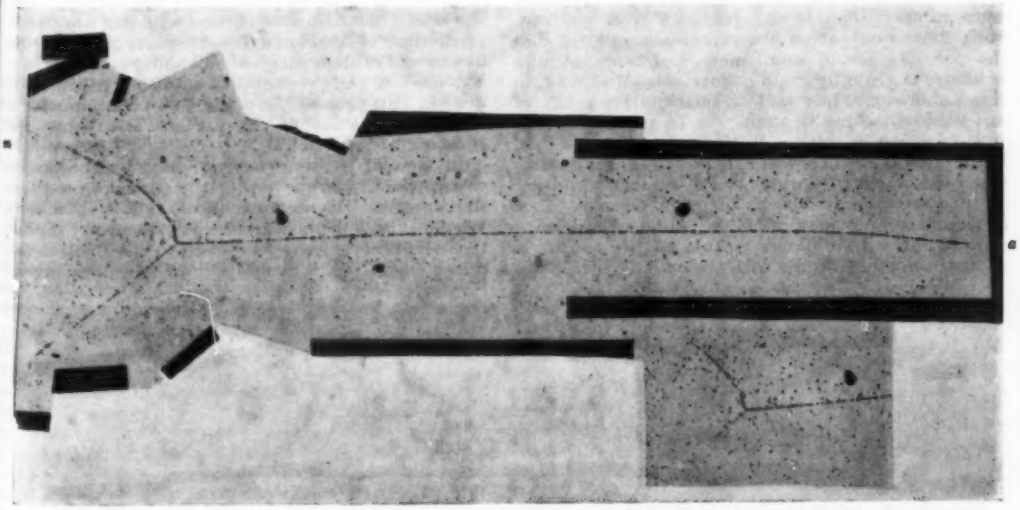

Fig. 2. COOKE × 45 'FLUORITE' OBJECTIVE, × 10 EYE-PIECE: DIRECT PHOTOGRAPHY WITH 'TELE-PANTO' PROJECTION MICROSCOPE. THE LONG TRACK *a* WHICH ENDS IN THE EMULSION IS PRODUCED BY A PARTICLE WITH A CHARGE EQUAL TO THAT OF THE PROTON. C2 EMULSION LOADED WITH LITHIUM

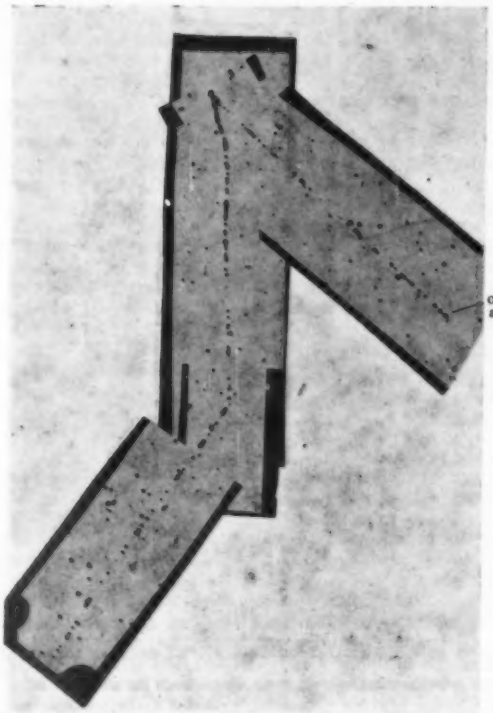

Fig. 3. Cooke × 95 'Achromat' objective with × 4 eye-piece. Direct photographs with projection microscope. C2 emulsion loaded with boron

Observations on the tracks of the slow particles indicated that the Coulomb scattering is more frequent than is to be expected if the particles are protons. Further, in moving along the trajectory, the increase in the grain density in the track, on approaching the centre of the star, is found to take place more rapidly than if the particles were protons. Both these qualitative observations suggested that the particles are of small mass, but more definite evidence is given by grain counts. Mr. Muirhead, in this Laboratory, has made a quantitative study of this subject, which is analogous to the problem of drop-counting in work with the expansion chamber. He has determined the variation of the grain-density along the tracks of protons in the emulsion in order to predict the distribution of grain density to be expected for particles with the same charge as a proton but with different values of the mass. A comparison of his results with the actual distribution of grains in the tracks of the particles producing the disintegration enables an estimate to be made of the mass of each particle. The values so obtained range from 100 m_e to 230 m_e, where m_e is the mass of the electron.

As in the case of drop-counting in experiments with Wilson chambers, any conclusion based on grain counting must be accepted with reserve. The latent image produced by charged particles in the 'Nuclear Research' emulsion is subject to fading, and although this effect is less marked in the types *B*2 and *C*2 than in *E*1 and *C*1, it is very serious in the usual exposures of six months duration. With this in mind we limited our exposures to six weeks; but even so the 'oldest' tracks obtained are subject to some fading. This will lead to an under-estimate of the mass of the particles, and Dr. Wassermann in this Laboratory therefore made observations by an alternative method based on measurements of the frequency of the Coulomb scattering of the particles.

Measurements on the tracks of the slow particles indicated that the number of deflexions which they suffer before being brought to rest is approximately three times greater than that of a proton of the same range. The expected frequency of scattering of particles of different mass, if they are subject only to Coulomb forces in collisions with nuclei of the atoms composing the emulsions, can be calculated. The observed frequency of scattering can thus be shown to correspond to a mass of the particle of 350 $m_e \pm 100$.

The estimates of the mass of the particles by both methods are subject to large statistical errors due to the small number of tracks available for measurement, and they give no basis for assuming that we are dealing with particles of different types. They show conclusively, however, that the particles have a mass less than one fifth of that of a proton.

During the last few years, following the pioneer experiments of Rasetti, a great deal of evidence has been accumulated concerning the fate of mesons, which can be summarized as follows. Positive mesons decay with the emission of an electron which can be detected by delayed coincidence experiments. On the other hand, in accordance with the theoretical predictions of Araki and Tomonaga, negative mesons at the end of their range do not suffer such a β-decay but have a high probability of being captured by nuclei. This process has previously been supposed to involve excitation of the nucleus and subsequent emission of β-particles.

In view of the evidence provided by the present experiments, we believe that the particles producing the observed disintegrations are negative mesons. We consider our photographs as evidence of the fact that the entry of the particle into the nucleus produces excitation, which is followed by the emission

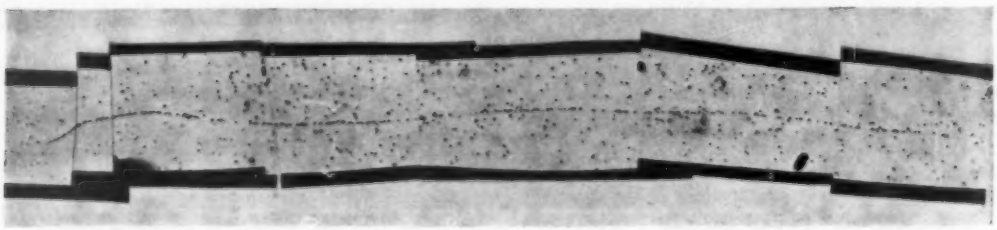

Fig. 4. Cooke × 95 'Achromat' objective, with × 4 eye-piece. Direct photographs with projection microscope. Unloaded C2 emulsion

Fig. 5. COOKE × 45 'FLUORITE' OBJECTIVE, × 4 EYE-PIECE. TWO α-PARTICLES AND A PARTICLE OF LOW RANGE, POSSIBLY AN ELECTRON, ARE EJECTED IN THE DISINTEGRATION. *C*2 EMULSION LOADED WITH BORON

of heavy particles. In support of the general picture of the fate of the positive and negative mesons, we find examples of tracks which end in the emulsion and which we identify as positive mesons, an example being shown in Fig. 4. Such tracks are distinguished by inspection, from the much larger number of disintegration protons ending in the emulsion, by the frequency of the small-angle scattering which they display, and up to the present ten examples have been found. Grain counts in every case lead to an estimate of the mass of the particle equal to or less than 230 m_e.

In addition to the determination of the mass of the particle, a second quantity of great interest is the energy released in the disintegration. In the particular disintegration shown in Fig. 1, all but one of the ejected particles pass out of the emulsion before reaching the end of their range. Further, because we regard the momentum of the particle producing the disintegration as very small, the observed directions of ejection of the disintegration particles make it necessary to assume, at least in some cases, that neutrons or other particles unrecorded by the emulsion have also been emitted. In these circumstances we cannot make a precise estimate of the total release of energy in any one of the disintegrations of this type which we have observed, and thus make a comparison of this quantity with the rest-energy of the particles producing the disintegration.

These considerations suggest that the most favourable conditions of observation for the determination of the mass of the particles will be provided in work with thick emulsions loaded with the light elements. It is possible, for example, that reactions such as those represented by the equations

$$Li^6_3 + m^0_{-1} \rightarrow H^3_1 + H^3_1 \text{ and } B^{10}_5 + m^0_{-1} \rightarrow He^5_2 + He^5_2$$

may take place. Reactions of this type would be particularly easy to identify since they would lead to the ejection of two particles of equal range, moving in opposite directions from the disintegrating nucleus.

We are greatly indebted to the director of the Observatory of the Pic du Midi, Prof. J. Baillaud; to Dr. M. Hugon and Prof. Max Cosyns, who made it possible for us to obtain the exposures; to Mr. H. Muirhead and Dr. G. D. Wassermann, for making available to us the results of their work on the determination of the mass of charged particles; and to Mr. C. M. G. Lattes and Mr. P. H. Fowler for a number of discussions.

Note added in proof. Since this article was communicated, D. H. Perkins has published (*Nature*, January 25, p. 126) a photograph of an event similar to those we have discussed, and his conclusions are

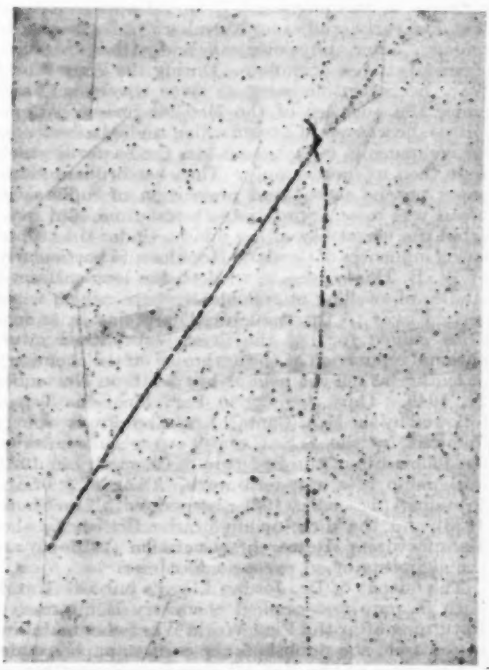

Fig. 6. COOKE × 95 'ACHROMAT' OBJECTIVE, × 4 EYE-PIECE. A FAST PARTICLE, POSSIBLY A PROTON, AN α-PARTICLE AND TWO HEAVY 'SPLINTERS' ARE EJECTED BY THE DISINTEGRATING NUCLEUS. UNLOADED *C*2 EMULSION

substantially identical with our own. The observed difference in the grain spacing of the meson tracks, in the *B*1 and *C*2 emulsions employed in the two experiments, is in good accord with expectations based on the known recording properties of the two types. The agreement between the results of observers in two different laboratories, working entirely independently with different experimental material, is a definite proof of the reliability of the photographic method in its present stage of development.

We have recently completed mosaics of two more of the six disintegrations referred to above, and reproductions of them are given in Figs. 5 and 6. We have also observed a number of disintegrations in which particles are emitted which are scattered more frequently than a proton of the same range, but which are more heavily ionizing than a meson of mass 240 m_e.

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OBITUARIES

Dr. D. Jordan Lloyd

DOROTHY JORDAN LLOYD was born in 1889, the daughter and grand-daughter of two prominent surgeons in Birmingham. It would appear natural that her early studies at Newnham College were in zoology, later physiological and then physico-chemical studies of muscle. During the First World War, her scientific pursuits were diversified, and under the auspices of the Medical Research Committee she was one of a team which studied substitutes for components of culture media for bacteria which were then in short supply. Then her brilliant short paper on the causes and prevention of ropiness in bread was most appropriate to war-time, and indicated the versatility of her mind. Under the stimulating influences of Gowland Hopkins and particularly of W. B. Hardy, she was led to the long-sustained studies of swelling in colloidal systems, which when carried over to the 'structured' proteins in animal skins gained for her the firmly established international reputation as the authority on the chemistry of leather which she held at her death on November 21, 1946. Thus, zoology in Part II of the Tripos followed by the M.A.(Cantab.), research in physiology followed by the D.Sc.(Lond.), after some interval the fellowship of the Institute of Chemistry in 1922, authorship of a standard work, "Chemistry of the Proteins" (first edit., 1926; second, with Ann Shore, 1938) and the directorship of the British Leather Manufacturers' Research Association (1927–46) are the signposts of an exceptional career.

The output of Dr. Jordan Lloyd's published work both in pure and applied chemistry is impressive. Returning after the First World War to her main line of research, she published her earliest papers under the auspices of the Medical Research Committee on the swelling of gelatin; but most of her work on this subject, and indeed by far the greater part of her scientific publications, was published after she joined the staff of the British Leather Manufacturers' Research Association in 1921. Her early work followed on that of Procter by establishing the swelling curves of gelatin as affected by hydrogen ion concentration, and demonstrating the effect of salts on the swelling. Later she showed how lyotropic effects are superimposed on the swelling effects of the Gibbs-Donnan theory, and illustrated the temperature effects which that theory predicts. She emphasized the importance of the balance between osmotic pressure and cohesion in controlling the degree of swelling. This work was extended to a study of the swelling of protein fibres (collagen, silk, hair) in aqueous systems, in which not only the water uptake but also the changes in length and thickness of the fibres were followed; these changes are of importance in giving a more detailed picture of the effects of swelling on the individual fibres and on the interwoven structure of hides. These studies of fibres showed the effect of hydrogen ion concentration on swelling, in so far as it produces salt formation by the protein, and also illustrated certain lyotropic effects. The weakening of the structure of the fibres which was observed in certain conditions was linked with the study of the molecular structure of fibrous proteins.

A number of Dr. Jordan Lloyd's papers deal with the closely related subjects of the chemical make-up of the fibrous proteins, and its bearing on their structure, water relationships and swelling properties. She carried out experiments on the amount of water in gelatin which is 'bound', that is, associated with specific groups in the protein molecules, and is to a considerable extent independent of osmotic effects. In addition to these studies of the molecular structure of fibrous proteins, she investigated the fibrous structure of hides and skins, and showed how the swelling properties of collagen fibres are affected by the sheath or network ('reticulin') which surrounds them and can be broken by strong swelling or weakened at very low and very high *p*H values.

The above work dealt with proteins in aqueous systems. In later developments Dr. Jordan Lloyd turned to a study of the effects of non-aqueous liquids (organic solvents and acids), using changes in volume, dimensions and extensibility of fibrous proteins in these liquids, to throw light on the nature of the cross-bonds which hold the protein molecules to one another, and on the orientation of these molecules in the fibres.

Her keen sense of the applicability of this mass of scientific results to the processes of the industry was coupled with a resolution and an unfailing affability towards industrialists and their technicians which was an immense advantage to the Research Association. The long series of her lectures, well attended by its members and their technical personnel, and based on the work in progress in the Association's laboratories, were symptomatic of her hold on the imaginations of those in the industry, and illustrated her wide grasp of the application of science to it. In the industry the measurement of hydrogen ion concentration and buffer index became usual, particularly in heavy-leather tanning; the use of the microscope and the correlation of photomicrographs with composition and use of tan liquors led to control of quality in leather in general and also in its production for special purposes—a control not hitherto attained; the disposition of the tanned fibres in leather is now related to its various measurable physical properties, and hence to quality and serviceability—such have been developed largely by her leadership and enthusiasm, which have contributed

much to the gradual change of leather production from a chancy industrial art to a sequence of processes scientifically controlled.

Miss Jordan Lloyd was perhaps unique among the scientific women of her time—a vigorous and vivacious leader of her mixed team both in triumph and tribulation (for her laboratories were twice wrecked in the 'blitz' on Bermondsey); a clear thinker and good speaker with a constructive mind; a manager with ability to delegate; a research worker herself who displayed an arresting interest in the investigations of many others; and with a demeanour and practical outlook in the tanneries which appealed to the employers and their technicians. She can have perhaps no more fitting epitaph—and one possibly no more welcome to her—than the impressive volumes now appearing which describe the results of twenty-five years of research for the British leather industry by the British Leather Manufacturers' Research Association under her inspiring leadership.

ROBERT H. PICKARD

We regret to announce the following deaths:

Dr. F. F. Blackman, F.R.S., formerly reader in botany in the University of Cambridge, on January 30, aged eighty.

Prof. James H. Leuba, emeritus professor of psychology at Bryn Mawr College, Pennsylvania, on December 8, aged seventy-eight.

Prof. L. W. Lyde, since 1928 emeritus professor of geography in the University of London, on January 24, aged eighty-three.

Dr. F. B. Mumford, emeritus dean of the College of Agriculture, University of Missouri, on November 12, aged seventy-eight.

NEWS and VIEWS

Advisory Council on Scientific Policy: Sir Henry Tizard, K.C.B., F.R.S.

Mr. Arthur Greenwood, Lord Privy Seal, has announced in a Parliamentary written reply that it has been decided, in addition to the establishment of the Defence Research Policy Committee, to set up on the civil side an Advisory Council on Scientific Policy to advise the Lord President of the Council in the exercise of his responsibility for the formulation and execution of Government scientific policy. The chairman will be Sir Henry Tizard, who is also chairman of the Defence Committee, and the staffs of the two bodies will work in close association. The Council will include the heads of the principal Government scientific organisations and a number of scientific workers from outside the Government service. The former Scientific Advisory Committee will now cease to exist. The latter, it will be recalled, was set up in October 1940, and consisted of the president and secretaries of the Royal Society, and the secretaries of the chief Government research departments, under the chairmanship of Lord Hankey. In the new Advisory Council the choice of membership has been somewhat extended, but presumably its functions will be roughly the same.

As chairman of the Defence Research Policy Committee and also of the Advisory Council on Scientific Policy, Sir Henry Tizard will occupy a unique position in the scientific life of Great Britain. For this he is admirably fitted. Apart from a distinguished academic record which gave promise of exceptional ability, his work during and after the First World War in aeronautical research and his influence on British aircraft development made him well known in scientific and engineering circles. A short period (1927–29) as permanent secretary of the Department of Scientific and Industrial Research when that Department was becoming established gave him first-hand knowledge of State administrative machinery. From 1929 until 1942 he was rector of the Imperial College of Science and Technology, London, and since 1942 he has been president of Magdalen College, Oxford. Thus he has unusual experience in scientific, engineering and administrative fields such as few can boast, which makes the choice of Sir Henry for the chairmanship of the new bodies for the organisation of defence and scientific research a particularly appropriate one.

Thomas Alva Edison (1847–1931)

Thomas Alva Edison was born in the then village of Milan, Ohio, on February 11, 1847, and died at West Orange, New Jersey, on October 18, 1931, at the age of eighty-four. Many years before Edison's death, Sir Richard Gregory wrote in his "Discovery, or the Spirit and Service of Science", "Thomas A. Edison is the embodiment of the method of specialised research with a practical purpose. By quickness of perception, fertility of resource, and persistent trial of everything until the best means of achieving his end has been found, he has become the leading inventor in the world." It is not far short of seventy years since the journalists of America raised him to the status of a sort of national hero. His first triumph was achieved when as a boy of fifteen he set up, printed and published a newspaper on a running train. By twenty-one he had secured the first of his thousands of patents and resigned an appointment with a telegraph company in order to bring out his inventions. From that time, patent followed patent, and in 1876 he founded the famous laboratory at Menlo Park, New Jersey, where he employed both men of science and men of skill to carry out his ideas. In quick succession came a series of innovations in telegraphy and telephony, the phonograph, photography, and in all that appertained to the generation, distribution and utilization of electricity. All that he did has to be studied with a knowledge of what had been and was being done by others, for he always made the fullest use of contemporary discoveries.

It was largely through the exhibition of Edison's 'Jumbo' dynamos and the incandescent lamp, in the United States and at the Paris Exhibition, that his reputation became world-wide. From his work on these things sprang the plans for the Pearl Street Electric Power Station in New York and the similar station at Holborn Viaduct, London, both of which were put into operation in 1882 for lighting the neighbouring streets and business premises. Some four hundred lamps in the telegraph operating room in the General Post Office, Newgate Street, were supplied with current from Holborn Circus. Edison was only thirty-five at this time, but he was probably at the height of his powers. His work and list of patents taken out afterwards, however, is impressive. In fertility of ideas he was perhaps only rivalled by his countryman Hiram Maxim. In later life he was

accorded many honours, but he probably appreciated as much as any the award to him in 1892 of the Albert Medal by the Royal Society of Arts. Only one American, Eads, the great bridge builder, had received it previously. Of Dutch descent on his father's side, Edison came of a long-lived family, and he could tire out any of his staff. His mother, to whom his debt was great, was of Canadian-Scottish descent. He himself was twice married and had six children. The Menlo Park laboratory has now been removed to Mr. Henry Ford's Industrial Museum at Dearborn, Michigan; it is a worthy memorial.

New York Academy of Medicine: Centenary Celebrations

THE first meeting of the New York Academy of Medicine was held on January 6, 1847, when the founders dedicated themselves to the establishment of an institution for the improvement of medical education, the advancement of the public health, the elimination of quackery and malpractice and the instruction of the public on matters of health and hygiene. Centenary celebrations will begin on March 6, with an assembly of the fellowship and the friends of the Academy, when the centennial discourse will be delivered by Prof. John A. Ryle, head of the Institute of Social Medicine at Oxford, who will speak on "Social Pathology and the New Era in Medicine". Following this meeting, a series of activities in the Academy building have been planned which will continue throughout March and April. Each of the eleven sections of the Academy will celebrate the centennial with a dinner of its own members, followed by a meeting in which eminent authorities in the specialty will participate. Each of the Academy's standing committees has arranged for a three-day conference, dealing with post-graduate medical education, public health, social medicine, hospitals and medical libraries respectively.

Various affiliated clinical and scientific societies such as the Harvey Society, the Society for Experimental Biology and Medicine, the New York Academy of Sciences and the New York Chapter of the American Chemical Society have accepted invitations to hold meetings in the Academy building during the period of the celebration. A historical exhibit of the Academy and its role in medical progress over the past one hundred years is being assembled and will be on view in the Academy throughout March and April. An exhibit is also being assembled in collaboration with the New York City Planning Commission and hospital authorities dealing with the history of the older municipal and voluntary hospitals of the city, at which plans for their post-war development will be shown. Special public exhibits on medical and historical subjects are being arranged at the Metropolitan Museum of Art, the New York Public Library, the New York Historical Society, the Museum of the City of New York and at private art galleries which possess famous prints, collections and other *memorabilia* on the medicine of a hundred years ago. Dr. George Baehr, president of the Academy, will broadcast an address on "A Hundred Years of Medical Progress".

Atomic Research in India

IT is reported (*J. Sci. Ind. Res., India*, **5**, 90; Aug. 1946) that the Atomic Research Committee of the Council of Scientific and Industrial Research, India, has recommended an intensive geological and physico-chemical survey of the thorium-bearing minerals in Travancore, and set up a sub-committee to draw up proposals for a similar survey of uranium-bearing minerals in India. The Committee considers that atomic research should be given first priority and encouraged by the Government of India on a large scale. However, as it is likely that only small sums will be available for the purpose, it will be necessary to concentrate research at one centre in the country. The centre recommended is the Tata Institute of Fundamental Research in Bombay, where a 300 MeV. betatron, with a team of ten workers to operate it, is to be established. Grants, to Prof. M. N. Saha for operational expenses of a cyclotron, and to Prof. D. M. Bose for research on the trans-uranic elements, were also recommended by the Committee.

A New Polarizing Light-Filter

DR. BRUCE BILLINGS, of the Polaroid Research Laboratory (Polaroid Corporation, Cambridge 39, Mass.), has recently given to the American Astronomical Society and the American Association for the Advancement of Science an account of a new type of light filter, making use of the familiar process of building up a filter by the use of crystal plates. Dr. Billings has varied the method by using plates the optical characteristics of which change under the influence of an electric field. This admits of much more rapid and easily controlled changes in the wave-lengths transmitted through the filter than was possible with earlier types. No details are given in the account available as to the narrowness of the band of transmitted light; but it is claimed that it allows for changes in the velocity in the line of sight in prominence streamers so as to give a complete record of the motions of parts of a prominence from a series of pictures taken at different wave-lengths in rapid succession. This promises a marked advance in our knowledge of the three-dimensional structure and whirling motions in prominences, just when they are becoming of increased interest to the student of solar and terrestrial phenomena. Further details will be awaited with interest.

Kew Bulletin

IT will be welcome news to botanical systematists that publication of the *Kew Bulletin* has been resumed after a lapse of nearly five years. The last number to appear was No. 3, 1941, which was issued in March 1942, and publication was thereafter suspended until No. 1, 1946, which has just been issued (London: H.M. Stationery Office, Dec. 1946, 2*s*. 6*d*.). It contains a continuation of the additions to the flora of Borneo and other Malay Islands, a part of which was published in 1940, a key to the Carices of Malaysia and Polynesia, notes on some species of the genus *Cryptolepis*, and a description and figure of a new species of *Arisæma* as principal contents.

Spiral Cracks in Glass Tubing

W. P. THISTLETHWAITE, Merchant Venturers' Technical College, Bristol, writes: "A few days after the appearance in *Nature* of October 19 (p. 582) of a letter on this subject, a student brought to me a test-tube exhibiting a perfect spiral crack. The tube was new but notched at the mouth, and was being used to heat a mixture of sand and ammonium chloride. Apparently the crack appeared immediately on contact with a bunsen flame; it originated at the notch in the lip of the tube. That the crack was

complete and not merely superficial was shown by the concertina-like behaviour of the tube when pulled."

Summer School in Theoretical Physics and Conference on Mechanical Properties of Solids

THE University of Bristol, in co-operation with the Institute of Physics, is arranging a Summer School in theoretical physics, with particular application to cohesive forces in metals and mechanical properties of solids, to take place during July 2–5. Lectures will be given by Prof. N. M. Mott, Dr. H. Fröhlich, and other members of the staff of the Laboratory. The course will be followed by a Conference on the Mechanical Properties of Solids (July 7–9), at which papers on the experimental and theoretical aspects of the subject will be given by research workers from Great Britain and abroad. The Summer School is intended mainly for members of staffs of Government and industrial research laboratories who wish to familiarize themselves with the theoretical aspects of subjects on which they have carried out experimental investigations. Subjects to be treated will include: cohesive forces in metals and elements of the zone theory; properties of Taylor dislocations; the Griffith crack theory; deformation of non-metals and theories of viscosity of liquids. The Conference will deal with the same subjects, and the lectures in the Summer School will be designed to provide the theoretical background for the discussions of the Conference. There will be no fee for the Conference, and it is not envisaged that everyone attending the Conference will wish to attend the Summer School. Accommodation will be reserved for a limited number at the University hall of residence, Wills Hall, Stoke Bishop, Bristol, 9. Particulars as to admission and as to the fees payable for the Summer School can be obtained either from the Secretary of the Institute of Physics, 47 Belgrave Square, London, S.W.1, or from the Director of the Department of Adult Education, University, Bristol

Symposium on Coal, Petroleum and Their Newer Derivatives

THE Scottish Sections of the Royal Institute of Chemistry have arranged a symposium on "Coal, Petroleum and Their Newer Derivatives" to be held at St. Andrews during July 7–12. The conveners have received much help from the Principal of the University of St. Andrews, and the staff of the Department of Chemistry of the University. The symposium is designed to give industrial scientists and others a comprehensive idea of developments which have been made in recent years in heavy organic chemistry. The first part of the symposium will deal with the raw materials and their sources, the second part with chemical syntheses, and the third part with physical-chemical problems of polymerization, etc. Both academic and industrial aspects of the problem will be discussed. Each lecture will be followed by a short interval for discussion, and on the last day there will be a general discussion and the position will be reviewed. Those attending the symposium may be accommodated in the students' residences. Arrangements have been made for accommodation from arrival on the evening of July 5, until the morning of July 12. Bookings will commence on March 1, and applications should be forwarded to the Secretary, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

Royal Microscopical Society: Officers

THE following have been elected officers of the Royal Microscopical Society: *President*: Dr. J. R. Ludford; *Vice-Presidents*: Dr. G. M. Findlay, Mr. C. F. Hill, Dr. James A. Murray, Dr. T. E. Wallis; *Hon. Treasurer*: Mr. S. R. Wycherley; *Hon. Secretaries*: Mr. F. C. Grigg, Dr. H. Moore; *Ordinary Members of Council*: Mr. F. D. Armitage, Dr. L. P. Clarke, Dr. F. Greenshields, Major Maxwell Knight, Mr. Chetwynd Palmer, Mr. R. Ross, Mr. D. J. Scourfield, Mr. J. Smiles, Mr. H. Gilbertson Smith, Mr. E. Wilfred Taylor, Dr. C. Tierney, Mr. J. M. Watson; *Hon. Editor*: Dr. G. M. Findlay; *Hon. Curator of Instruments*: Dr. C. Tierney; *Hon. Curator of Slides*: Mr. N. Ingram Hendey; *Hon. Librarian*: Mr. R. Ross.

Royal Meteorological Society: Officers

THE following have been elected officers of the Royal Meteorological Society: *President*, Dr. G. M. B. Dobson; *Vice-Presidents*, W. Dunbar, G. Manley, Sir Charles Normand, J. F. Shipley; *Treasurer*, W. M. Witchell; *Secretaries*, E. L. Hawke, Wing-Comdr. R. M. Poulter; *Scottish Secretary*, A. J. Drummond; *Foreign Secretary*, L. C. W. Bonacina; *Editor*, Dr. R. C. Sutcliffe; *Council*, A. C. Best, G. S. Callendar, J. S. Forrest, Capt. L. G. Garbett, Major H. C. Gunton, W. G. Kendrew, I. T. D. Kirkpatrick, Dr. A. R. Meetham, Dr. F. J. Scrase, P. A. Sheppard, A. E. Slater, Dr. T. W. Wormell.

Announcements

PRINCESS ELIZABETH has been elected a Royal Fellow of the Royal Society.

PROF. A. A. HALL, Zaharoff professor of aviation and head of the Department of Aeronautics, Imperial College of Science and Technology, has been appointed a member of the Air Safety Board.

DR. FRANZ WEIDENREICH, of the American Museum of Natural History, is the first recipient of the newly created Viking Fund Medal and Prize in Physical Anthropology, for his many contributions to palæoanthropology, and especially for his very important recent studies on fossil man in China and Java. Dr. Weidenreich was presented with the Viking Fund Prize of 1,000 dollars at the annual meeting of the American Association of Physical Anthropologists on December 28.

MR. C. L. BIRD, lecturer in dyeing in the University of Leeds, has been appointed editor of the *Journal of the Society of Dyers and Colourists* in succession to the late Prof. F. M. Rowe.

To commemorate the centenary of the Chemical Society, which was founded at a meeting on February 23, 1841, in the rooms of the Society of Arts, a special joint meeting of the two Societies will be held at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2, on February 19 at 5 p.m. Viscount Bennett, president of the Royal Society of Arts, will preside, and Sir Harold Hartley will speak on "A Century of Chemistry". Tickets of admission will be available on request to the Secretary, Royal Society of Arts.

OWING to continued public interest, the "March of Time" film entitled "Atomic Power" will continue to be shown at the Science Museum until February 23, by courtesy of Messrs. 20th Century Fox Film Co., Ltd. It is being shown on weekdays at 2.30 p.m., and on Sundays at 3.15 and 4.15 p.m. Admission is free.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Nature of Myosin

We have been led to regard 'myosin' as a rather involved system of substances, in spite of the fact that it readily crystallizes and behaves as a homogeneous substance on recrystallization. It consists of a skeleton to which are adsorbed a number of protein-like substances. The skeleton, and also the adsorbed proteins, are, in themselves, inactive, their system being only capable of enzymic reactions and of contraction. The adsorbed substances all seem to belong to the same remarkable group of substances, characterized, in impure condition, by their stability in 0·1 *n* hydrochloric acid at 100° (15 min.). They can be treated with *n* hydrochloric acid or precipitated by trichloro-acetic acid without loss. These substances will be called 'protins', to distinguish them from other proteins. H. M. Kalckar was the first to describe, in muscle, an acid- and heat-stable protein, his 'myokinase'.

So far, we have been able to recognize the existence of 'protins', involved in the following reactions of 'myosin': (1) 'ATP-*P*-protin', involved in the dephosphorylation of adenosine-triphosphate (Banga). (2) 'ATP-*c*-protin', involved in the contraction of myosin, linked to fibrous actin, in presence of adenosine-triphosphate (Guba). (3) 'ATP-*N*-protin', involved in the deamination of adenosine-triphosphate by myosin (Banga). (4) 'ADP-*P*-protin': dephosphorylation of adenosine-diphosphate (Banga). (5) 'ADP-*N*-protin': deamination of adenosine-diphosphate (Banga). (6) 'ADP-*c*-protin'; contraction of myosin, linked to actin, in presence of adenosine-diphosphate (Guba).

(1) and (2) are probably identical. (4) and (5) may be identical since deamination of adenosine-diphosphate always goes *pari passu* with dephosphorylation (Banga). If (4) and (5) are identical, the substance cannot be identical with (6), which is a chromoproteid and can be inactivated by oxidation and reactivated by reduction (Guba); (4) and (5) can be inactivated by oxidation but cannot be reactivated by reduction. (6) may be identical with either (4) or (5) if they are different substances. (3) and (5) are definitely different, and so are (1) and (3).

The 'protins' can be found in free condition in a watery muscle-extract and can be readsorbed to the skeletal substance of myosin, forming an active complex again. The 'protins' involved in the reactions with adenosine-diphosphate can be removed relatively easily from myosin if the latter is poor in actin: it suffices to suspend the myosin over-night in a bigger volume of 0·025 *m* potassium chloride at 0°. The 'protins' involved in the reactions with adenosine-diphosphate can be removed only under special conditions. In this case the myosin must be entirely free of actin. In order to inactivate her myosin for the phosphatase test with adenosine-triphosphate, Banga suspended it (1 mgm. per ml.) in 0·5 *m* potassium chloride, containing 0·2 *m* acetate-buffer of *p*H 6, and stored it for two days at room temperature. Guba suspended his myosin in big volumes of 0·025 *m* potassium chloride of *p*H 6 for 5–36 hours at 0°, depriving it of contractility in presence of adenosine-triphosphate. One of his preparations, which was inactive in the contraction test, was still 50 per cent active as phosphatase. As the 'protins' are washed off, the skeletal substance becomes more and more insoluble and seems to denature. Hydrogen ions favour the dissociation of skeletal substance and 'protins' but at the same time tend to denature, the limits of both processes lying very close together. If the enzymic activity was reduced by more than 85 per cent, Banga was unable to obtain reactivation. On readsorption of 'protin' to the skeletal substance, the solubility of this latter increases.

The skeletal substance of myosin seems to be distinguished by a high adsorption power not only towards 'protins' but also towards different anions, cations, adenosine-triphosphate and other substances as well. Only the full system, containing the skeletal substance, with 'protins', potassium, magnesium, adenosine-triphosphate, possibly other anions and a special cerebroside (Guba and Szent-Györgyi) adsorbed, is active as contractile matter. This system is capable of contraction if linked to fibrous actin.

The conditions described may seem rather extraordinary. It must be remembered, however, that myosin is the first structural protein, analysed to this extent, performing a basic biological function and having two distinct states, characterized by a difference in free energy.

This research was sponsored by the Josiah Macy, Jr. Foundation, New York.

I. Banga
F. Guba
A. Szent-Györgyi

Institute of Biochemistry,
University of Budapest.
Dec. 28.

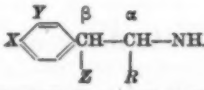
Molecular Asymmetry and Biological Activity

Easson and Stedman[1] have advanced the theory that the differences in biological activity between optical isomers should be considered in exactly the same light as the variations in potency shown by structural isomers. They pointed out that only one optical isomer can come into close contact with the specific receptors, and suggested that the weaker enantiomorph behaves as if one of the active groups is not present at all. In adrenaline, the active groups are: the amino group, the benzene ring with its phenolic hydroxyls, and the alcoholic hydroxyl group. By this view, *l*-adrenaline can come into complete contact with the receptors, and the weaker enantiomorph, *d*-adrenaline, cannot. Desoxyadrenaline (epinine) should, therefore, have the same activity as *d*-adrenaline, except in so far as the activity is modified by changes in physical properties by the presence of the alcoholic hydroxyl group. Easson and Stedman presented evidence that epinine and *d*-adrenaline do, in fact, have the same effect on blood pressure, and they also found support for the concept in drugs of the miotine type. If the theory is generally true, similar considerations should apply among compounds related to adrenaline: compounds containing a lævo-rotatory β-carbon atom should be the more active, and, with the above reservations regarding physical properties, the activity of the dextro-rotatory enantiomorphs should approximate to that of the desoxy-derivatives.

The theory received considerable support from Schaumann[2], who found that *d*-corbasil (dihydroxynorephedrine) has approximately the same activity as

desoxycorbasil (dihydroxyphenylisopropylamine), but that *l*-corbasil is about 160 times as active. On the other hand, Alles and Knoefel[3] found that phenylethylamine is much more active than *d*-phenylethanolamine when tested in dogs and cats. Other differences in biological activity were also found, and they concluded that these two compounds are not at all related in their activities as required by the theory of Easson and Stedman.

To examine the theory further, I have collected in the table below the published results on the pressor activities of optical isomers of compounds of the type



where X is OH or H, Y is OH or H, Z is OH or H, R is CH_3 or H, and R' is CH_3 or H. The figures quoted for *d*-adrenaline and for epinine have the advantage over those quoted by Easson and Stedman in that they were both obtained in the same laboratory[4]. Taken in conjunction with the other published figures comparing the activity of these compounds[4,5], it is not unlikely that epinine is significantly more active than *d*-adrenaline. Although strictly comparable results are not available, desoxysynephrine appears to be much more active than synephrine[6,7].

The problem is rather more complex in compounds related to ephedrine, which have two asymmetric carbon atoms. It has been customary, with compounds of this nature, to compare each isomer with its enantiomorph (that is, *l*-ephedrine with *d*-ephedrine); but this involves a reversal in the configuration of both the asymmetric carbon atoms. For the present purpose, it is more logical to compare the three compounds having identical configuration at the α-carbon atom, but differing in configuration at the β-carbon atom; that is, to compare *l*-ephedrine with *d*-ψ-ephedrine and *d*-desoxyephedrine, and to compare *l*-ψ-ephedrine with *d*-ephedrine and *l*-desoxyephedrine. The former group has a dextrorotatory α-carbon atom, the latter a lævo-rotatory α-carbon atom[8]. In this connexion it is significant that *l*-ephedrine and *d*-ψ-ephedrine are much more powerful mydriatics than *l*-ψ-ephedrine and *d*-ephedrine. Furthermore, the latter two compounds are inactive as pressors in man, *per os*, under conditions in which the former two compounds are active[9]. These results must, therefore, be associated with the configuration of the α-carbon atom.

Examination of the figures in the table shows that, if the theory of Easson and Stedman is correct, then the physical properties of the molecule must play a profound part in the biological activity; for the results, on the whole, are in poor agreement with the theory. The most abnormal results are given by the ψ-ephedrines and ψ-propadrines (norephedrines), which are very much less active than expected. It appears that for enhanced activity among compounds of this type, the optical rotation of the two asymmetric carbon atoms should be of opposite sign. This may be compared with the biological results obtained with quinine and related compounds, for Neeman[9] has pointed out that, for enhanced antimalarial activity, the optical rotation of C–8 and C–9 of the quinine derivative should be of the same sign.

G. M. Badger
(I.C.I. Research Fellow)

Department of Chemistry,
University of Glasgow.
Nov. 12.

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MOLECULAR ASYMMETRY AND PRESSOR ACTIVITY

Common name	Formula					Optical rotation		Pressor activity relative to *l*-adrenaline
	X	*Y*	*Z*	*R*	*R'*	βC	αC	
l-Synephrine	OH	H	OH	H	CH_3	—	Nil	1/58[6]
d-Synephrine	OH	H	OH	H	CH_3	+	Nil	1/3480[6]
Desoxysynephrine	OH	H	H	H	CH_3	Nil	Nil	1/108[7]
l-Adrenaline	OH	OH	OH	H	CH_3	—	Nil	1[4]
d-Adrenaline	OH	OH	OH	H	CH_3	+	Nil	1/20[4]
Epinine	OH	OH	H	H	CH_3	Nil	Nil	1/12[4]
l-Propadrine*	H	H	OH	CH_3	H	—	+	1/317[5]
d-ψ-Propadrine*	H	H	OH	CH_3	H	+	+	1/1900[5]
d-Benzedrine*	H	H	H	CH_3	H	Nil	+	1/270[5]
l-ψ-Propadrine*	H	H	OH	CH_3	H	—	—	1/1700[5]
d-Propadrine*	H	H	OH	CH_3	H	+	—	1/473[5]
l-Benzedrine*	H	H	H	CH_3	H	Nil	—	1/282[5]
l-Ephedrine	H	H	OH	CH_3	CH_3	—	+	1/142[5]
d-ψ-Ephedrine	H	H	OH	CH_3	CH_3	+	+	1/735[5]
d-Desoxyephedrine	H	H	H	CH_3	CH_3	Nil	+	1/787[5]
l-ψ-Ephedrine	H	H	OH	CH_3	CH_3	—	—	1/5000[5]
d-Ephedrine	H	H	OH	CH_3	CH_3	+	—	1/420[5]
l-Desoxyephedrine	H	H	H	CH_3	CH_3	Nil	—	1/555[5]

* Tested as *l*-mandelates.

THE hypothesis which Easson and I formulated to explain the quantitative differences between the physiological activities of optical enantiomorphs is simple and apparently without an alternative; its examination, moreover, is likely to throw light on obscure features in the general relationship, which undoubtedly exists, between chemical structure and biological activity. I therefore welcome attempts to examine further material with the object of testing its validity more extensively than has hitherto been possible.

The data which Dr. Badger has collected from the literature are, however, at first sight somewhat unsuitable for this purpose; the compounds involved possess, as compared with adrenaline, only small pressor activities; and the interpretation of the data is complicated by the presence in most of the compounds considered of a second asymmetric carbon atom. Nevertheless, despite these disadvantages, there is one striking regularity to be observed in the results: in each of the triads in which Dr. Badger has arranged the compounds, the abolition of the

asymmetry of the β-carbon atom by the replacement of the alcoholic hydroxyl by hydrogen results in the production of a compound which has a pressor activity of the same order of magnitude as that of one of the β-hydroxy compounds and widely different from that of the other. This result is, in my opinion, in general accord with the hypothesis in question.

That Dr. Badger has not observed this regularity, or has not noted its significance, but, on the contrary, considers the data to be at variance with the hypothesis, is, no doubt, due to his too limited interpretation of the original hypothesis. As Easson and I pointed out at the time it was formulated, in order to apply the hypothesis to a particular drug, it is necessary to decide which of the four groups linked to the asymmetric carbon atom are concerned with the attachment of the drug molecule to its receptor. In the case of adrenaline, a decision presents no difficulty. But because the alcoholic hydroxyl group in *l*-adrenaline has a very potent influence in determining the large pressor activity of the molecule as a whole, and can therefore be assumed to assist in attaching it to the receptor, it does not follow that the same effect will be produced by a hydroxyl group similarly situated in compounds which, while they may be structurally related to adrenaline, lack certain of its other potent groups and contain substituents which are absent from adrenaline. This is particularly the case when the activities of the compounds range from 1/58 to 1/5,000 of that of *l*-adrenaline and are thus considerably less active than even epinine, which possesses no alcoholic hydroxyl. To ascertain the effect of the hydroxyl on the union between drug and receptor, it is necessary to consider the change in pressor activity when it is replaced by hydrogen.

From the figures quoted by Dr. Badger, it is evident that with *l*-synephrine and *l*-propadrine there is little change, and it must therefore be assumed that in these cases the hydroxyl plays no part in the attachment of the drug and is therefore oriented away from the receptor. On the other hand, the corresponding hydroxy compounds with dextrorotatory β-carbon atoms are far less potent, suggesting that here the hydroxyl, now directed towards the receptor, creates an obstacle to the complete attachment of the drug to it. The triad containing *l*-ephedrine behaves like the adrenaline triad and need not, therefore, be considered further. There remain, however, the *l*-ψ-propadrine and *l*-ψ-ephedrine triads. These differ from the *l*-propadrine and *l*-ephedrine ones in containing a lævorotatory α-carbon atom, which is no doubt responsible for their different behaviour. With these last triads, substitution of the β-hydroxyl by hydrogen causes a large increase in pressor activity when the β-carbon is lævorotatory and practically no change when it is dextrorotatory. With the former, the hydroxyl is evidently oriented in the direction of the receptor, thus creating an obstacle to intimate union between the two; with the latter, it is directed away from the receptor and hence plays a passive part in the activity of the drug.

Since Dr. Badger has referred to the work of Alles and Knoefel on phenethylamine and its β-hydroxy compounds, I should like finally to point out that he does not mention the result, obtained by these authors, that "phenethylamine and *d*-β-hydroxyphenethylamine are rather similar in their pressor effects in the rabbit in certain dosage and both are less active than *l*-β-hydroxyphenethylamine". Evidently, in rabbits at the particular dosage involved, these drugs do follow the hypothesis in much the same way as does adrenaline. The reason why the same relationship is not apparent with higher doses, or when cats and dogs are used, is no doubt connected with Alles and Knoefel's finding that the drugs are in these circumstances also active towards other receptors. If different active groups are involved in the union with these receptors, it is quite clear that no regularity is then to be expected.

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Biosynthesis of the Belladonna Alkaloids

DR. W. O. JAMES, in his interesting paper on "Biosynthesis of the Belladonna Alkaloids"[1], states that the embryos and endosperms of the resting seeds of *Atropa* and *Datura* are without alkaloids, but that the latter appear at an early stage of germination.

Dr. Henry, in his "Plant Alkaloids", gives the following average total alkaloid figures for seeds:

Atropa belladonna	0·83 per cent
Datura metel	0·23 to 0·50 per cent
Datura stramonium	0·20 to 0·48 per cent

The results of numerous analyses have, in my experience, confirmed these figures. Since the embryo and endosperm constitute a large part of the bulk of the seed it would be interesting if Dr. James would indicate which part of the seed structure does in fact contain the alkaloids known to be present.

It may be of interest to record here that the juice of the ripe belladonna berry does not contain any alkaloids, and has a pleasant, sweetish but somewhat insipid taste.

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Nature, **158**, 654 (1946).

A NUMBER of independent investigators have examined the distribution of alkaloids in the tissues of *Atropa*[1,2,3] and *Datura*[1,2,4,5] seeds. They have used a variety of precipitants; but principally iodine in potassium iodide, which, with the technique developed by Errera[6] and his school, is the most dependable for revealing the whereabouts of alkaloids by precipitation within tissues. These workers are agreed that the belladonna and thorn-apple alkaloids are restricted in the ripe seed to the peripheral layers, that is, to the testa itself and especially to a thin layer of cells lying between the testa and the endosperm; probably a perisperm derived from the nucellus. This curious distribution is also found in the seeds of *Hyoscyamus*[1,4]. It has been confirmed in my own laboratory for those of belladonna[3]. Barth[5], examining *Datura stramonium* seeds that were not quite ripe, thought that there might be a little alkaloid also in the embryo and endosperm. Other investigators examining seeds that were fully ripe found none in either of these parts.

At the outset of germination, therefore, both endosperm and embryo are devoid of alkaloids, and Clautriau[1] obtained a completely alkaloid-free germination of *Datura stramonium* seeds by removal of the surface tissues. Normally, these alkaloids diminish[5], possibly on account of leaching out as salts from

their exposed position in dead peripheral cells[7,8]. The alkaloids of the seedling plants appear first at the root apices[1,9], and removal of the outer seed tissues does not cause any abnormalities in germination[1]. The formation of quantities sufficient for micro-extraction has been recorded for belladonna only after three weeks; for thorn-apple after eighteen days and for henbane after seven weeks[10]. By a technique recently described[9], I have been able to observe alkaloid formation in *Datura* radicles no more than 3 mm. long, but not in those 2 mm. long or less. Synthesis *de novo* appears, therefore, to set in at the very outset of germination, and is characteristically associated with high metabolic activity. The alkaloids of the ripe seed are survivors from the activity of the post-fertilization stage of the ovule, which at first contains alkaloids in all its tissues. The inner tissues lose their alkaloids during maturation either by breakdown *in situ* or by migration to the periphery.

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A Product of *Pseudomonas æruginosa* Active *in vitro* against *M. tuberculosis*

Information recently to hand in the lay press[1] that Theorell, Davide and Sjögren have developed an anti-tuberculosis remedy from the pyocyanic bacillus has prompted, at this early stage of its investigation, the following record of the isolation and characteristics of what may prove to be a similar organism.

On the assumption that if active antagonists to *M. tuberculosis* exist, they are likely to be found in the sewage tank of a tuberculosis sanatorium, various samples were treated by the Dubos enrichment culture method, tubercle bacilli being added at intervals over a period of five months. At the end of this time, an organism was isolated which showed a marked antagonistic effect to *M. phlei* and *M. tuberculosis*. This organism was identified as a strain of *Pseudomonas æruginosa*. The supernatant fluid of a twenty-day culture of this bacillus is inhibitory to a heavy inoculum of *M. tuberculosis* in a concentration of 1 in 80, and a crude chloroform extract is inhibitory in a concentration of 1 in 128,000. Even low concentrations are bactericidal in fourteen to twenty days. Exposure of *M. tuberculosis* to the action of the organism or its culture fluid extracts over short periods causes thickening, shortening, irregularity and beading, with progressive loss of acid-fastness. After some days, lysis of acid-fast organisms occurs.

The action of the Waterfall strain appears to be specific, as other strains of *Pseudomonas* tested have shown no antagonism to acid-fast bacteria. Further, in testing the activity of this particular strain against certain non-acid-fast types (*Staphylococcus aureus*, *Streptococcus hæmolyticus* and *Escherichia coli*), no antibacterial effect was observed.

The active substance is relatively heat-stable, but passage through a Seitz filter considerably reduces its potency. The most active preparations have so far been obtained from growth on a broth or liquid egg medium, but the antibacterial agent may also be obtained from growth on Youmans' or Dubos' medium. Chloroform extraction does not remove all the active material.

With the crude mixtures so far obtained, toxic effects are apparent in animals. 5 ml. of sterile culture fluid are sufficient to kill a guinea pig in twenty-four hours, while a mouse will survive a single subcutaneous injection of only 3–4 mgm. of a chloroform extract.

It has long been recognized that *Pseudomonas æruginosa* may secrete various antibacterial substances, among which are pyocyanine and its derivatives[2]. That the substance active against acid-fast organisms is not pyocyanine is suggested by the inactivity of ordinary strains, and by the fact that we have found pure *l*-hydroxy phenazine to be inhibitory in, at most, a concentration of 1 in 20,000.

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Dec. 17.

[1] *News from Sweden*, Sept. 18, 1946 (Amer.-Swedish News Exchange, Inc., New York).
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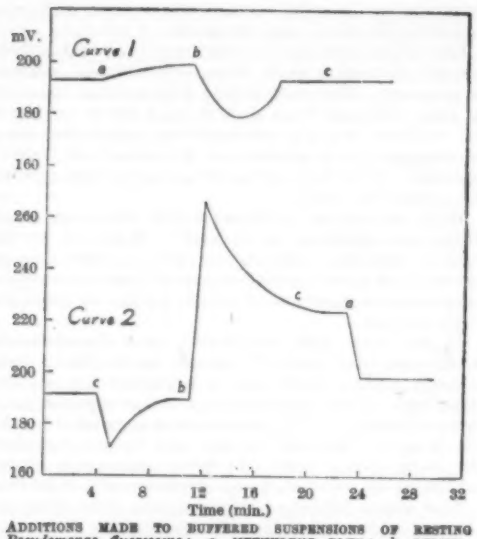
A Correlation between Redox Potentials and Synergisms in Resting Bacteria

The destruction of nicotinic acid by suspensions of resting *Pseudomonas fluorescens* has been shown to be an enzymatic oxidation[1]. We have found that the oxygen uptake was decreased when methylene blue was added, but was not affected upon addition of sulphapyridine. However, after addition of a mixture of these compounds, a synergistic inhibition was observed.

The bactericidal and bacteriostatic effects of oxidation-reduction indicator dyestuffs have often been correlated to their poising action. It was, therefore, believed that an inhibitory synergism in which such a dyestuff is involved might manifest itself in changes of the oxidation-reduction potential of the system. Accordingly, a test was carried out in which the redox potential of phosphate-buffered and aerated suspensions of resting *Pseudomonas fluorescens* was measured with the Beckman *p*H meter, against a blank platinum electrode.

The changes in the E.M.F. are recorded graphically in the accompanying figure. Curve 1 indicates at point *a* an increase of the E.M.F. upon the addition of methylene blue to a buffered bacterial suspension and nicotinic acid at equilibrium. When sulphapyridine was added, at *b*, a decrease was observed. After equilibrium had been reached again, further addition of nicotinic acid (*c*) did not change the E.M.F. Curve 2 shows an initial decrease of the E.M.F. upon the addition of nicotinic acid (*c*) to the buffered bacterial suspension; after equilibrium was reached, sulphapyridine (*b*) brought about an increase in the



ADDITIONS MADE TO BUFFERED SUSPENSIONS OF RESTING *Pseudomonas fluorescens*: *a*, METHYLENE BLUE; *b*, SULPHAPYRIDINE; *c*, NICOTINIC ACID

E.M.F., which decreased and remained constant even after the addition of more nicotinic acid. When methylene blue was added (*a*), a sharp decrease of the E.M.F. occurred. It was thus found that the sequence of addition of methylene blue and sulphapyridine was significant.

Notwithstanding the difficulty of obtaining reproducible values for redox potentials in biological systems, it is suggested that the synergism of methylene blue and sulphapyridine in resting *Pseudomonas* can at least be partially explained by a change of the redox potential, the sign of the change depending upon the sequence of addition of the components.

Guest and Salle[2] have observed that cations of the same element but of different valency show synergism in bactericidal action. The observations recorded here would indicate that synergisms, the factors of which poise the system to different redox potentials, can be partially explained; they give rise to potential differences within the bacterial suspension, which are greater, because of the reversal of sign, than those caused by each component alone, and are hence more effective.

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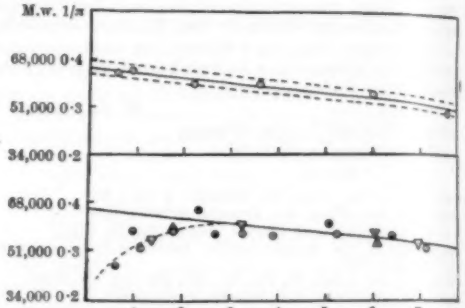
Osmotic Pressure of Fœtal Sheep Hæmoglobin

PREVIOUS osmotic pressure measurements on fœtal and maternal goat hæmoglobin[1] showed no significant differences in the molecular weights, which seemed in close agreement with the value of 68,000 reported for sheep hæmoglobin by Adair[2]. The present communication records some osmotic pressure measurements on the hæmoglobins of sheep fœtuses, aged 80, 92, 98, 102 and 112 days. The period of gestation in sheep averages 147 days.

Hæmoglobin solutions prepared by the method of Adair and Adair[3] were dialysed against $M/15$ phosphate buffer of *p*H 6·8. Osmotic pressure measurements were carried out by the method of Adair[4], the same buffer being used throughout.

The calculation of molecular weights from the osmotic pressures by a modification of van t' Hoff's law, and the determination by extrapolation of π, or the limiting value of the ratio P/C in the infinitely dilute solution, have been described by Adair and Robinson[5].



C = gm./100 ml. of solution. $1/\pi = C/P$.
Age of fœtuses in days: ● = 80, ◉ = 92, △ = 98, ▽ = 102, ○ = 112

The upper graph shows the relationship between $1/\pi$ and C obtained on a sample of maternal sheep hæmoglobin. Molecular weights corresponding to different values of $1/\pi$ are also presented. The calculated molecular weight is about 67,000. In the lower graph, data obtained on a number of samples of hæmoglobin from five fœtuses are shown. Extrapolation of the points obtained at higher concentrations indicate a molecular weight of 65,500 ± 2,500. At lower concentrations, however, the values of $1/\pi$ fall below the values expected from such extrapolation. The deviations are of a magnitude difficult to attribute to experimental error alone, and suggest the dissociation of fœtal hæmoglobin into smaller molecules on dilution. Further experimental data, however, are required on this point.

Andersch, Wilson and Menten[6] reported differences in the sedimentation constants of hæmoglobins prepared from human new-born infant and adult bloods. Diffusion constants were not measured, so the molecular weights were not calculated; but if the forms are identical, their findings would indicate that human infant hæmoglobin has a molecular size half that of adult hæmoglobin.

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Dec. 12.

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Experiments with Different Methods of Isolating Physiological Mutations of Filamentous Fungi

During recent years, I have tried various methods of isolating considerable numbers of X-ray induced physiological mutants in fungi, *Ophiostoma multi-annulatum* being the chief organism experimented on[1]. Of some six hundred mutants produced in this fungus, at present 463 are at least preliminarily classified, and thus the material in this case seems to be big enough to permit some general conclusions to be drawn as to the methods employed. 218 of these mutants have been isolated by the aid of some 'concentration method', the other 245 by the so-called 'total isolation method'. Some of the former were obtained from irradiated ascospores; but most of them, as well as all the latter, were produced by irradiating conidia of the (+)-strain No. 11.

The methods first mentioned imply a concentration of the mutants, in so far as the normal mycelia are to a great extent sorted out in some way before the isolation. The best procedure turned out to be the following one, here described quite briefly. The irradiated conidia are soaked with water at a low temperature for three days, and then they are transferred to a minimum nutrient solution at + 25° C. There the physiologically normal conidia germinate rapidly and develop small mycelia; the conidia with mutated nuclei, on the other hand, remain ungerminated, or develop only short hyphæ. Thus most of the former are removed by sieving the culture through a suitable filter, and most of the latter—together with all the conidia killed by the irradiation—are to be found in the filtrate. After washing the filtrate (by centrifuging), the latter part of the procedure is repeated once or twice more. The conidia in the final filtrate are then brought on to agar-plates containing malt-extract and yeast-extract. About 12–15 per cent of the mycelia developing in these plates are physiological mutants.

In using the 'total isolation method', the irradiated conidia are directly disseminated into malt-yeast-extract agar-plates, and all developing mycelia are isolated and tested. Of 13,405 mycelia isolated in this way, 245 turned out to be physiological mutants, that is, 1·83 per cent of the conidia surviving after irradiation and *c.* 0·02 per cent of all the conidia irradiated.

The accompanying table of the physiological properties of the mutants hitherto analysed shows that some types of mutations are obtained to about the same extent in both methods. Thus they are suitable for the parathiotrophic mutants (requiring bivalent sulphur), for the amino-acid-deficient mutants, and for those requiring a nucleotide constituent. As to the last-mentioned group, however, it will be noted that all the four guanine-requiring mutants have been obtained by means of concentration methods. The same holds good for the *p*-aminobenzoic-acid-heterotrophic mutants, among those requiring vitamins, whereas the great majority of the pantothenic acid and inositol-heterotrophic mutants have been obtained by the total isolation method. Possibly with the exception of the inositol-heterotrophic mutants, the mutated material is not yet extensive enough to decide whether the divergences in question are due to the different methods of isolation, or merely due to chance.

Here it may further be mentioned that a part of the irradiation experiments was performed with conidia impregnated with uranium (as uranyl nitrate). In this way a somewhat higher rate of mutations was obtained; but no definitely demonstrable changes in the qualitative composition of the yields of mutants could be observed, whether these were obtained by one or the other method of isolation.

Essential substance	Number of mutants isolated			
	Isolation method			Total
	'Concentration' *a*	*b*	'Total isolation' *b*	
Reduced sulphur	10	30	34	74
An amino-acid :				
Arginine	—	56	42	98
Lysine	—	22	32	54
Methionine	1	7	9	17
Aspartic acid	—	—	1 ?	1 ?
Not identified	—	3	5	8
A nucleotide constituent :				
Uracil	1	14	26	41
Hypoxanthine	4	43	51	98
Adenine	—	3	4	7
Guanine	1	3	—	4
Vitamin A				
Biotin	1	2	2	5
p-Aminobenzoic acid	3	1	—	4
Pantothenic acid	—	—	6	6
Inositol	—	2	18	20
Niacin	—	2	6	8
Unknown factor	1	8	9	18
Total	22	196	245	463

(*a*) Mutants obtained from irradiated ascospores. (*b*) Mutants obtained from irradiated conidia (Strain No. 11).

On comparing the results summed up in the table with those obtained in *Neurospora* by American workers[2], the following differences seem to be particularly striking[3]. Induced amino-acid deficiencies are found comparatively more often in *Neurospora* than in *Ophiostoma*, and many more different amino-acids are concerned. Moreover, in *Neurospora* more types of auxo-heterotrophies (requiring different growth-substances) have been produced, for example, lacto-flavine and choline heterotrophies. *Ophiostoma*, on the other hand, is characterized by the numerously occurring parathiotrophic strains, and by the big group of mutants requiring some nucleotide constituent.

The concentration method here described seems to be applicable to other filamentous fungi too, although, of course, the details of the procedure must be worked out specially for each object.

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Growth of a Planktonic Green Alga at Various Carbonic Acid and Hydrogen-Ion Concentrations

The use of phosphate buffer mixtures when culturing Algæ has been shown to have several disadvantages. High phosphate concentrations are often injurious to Algæ, and in alkaline solutions precipitates of slightly soluble phosphates are formed, thus withdrawing from the Algæ elements necessary for growth. Nor has it been possible to make growth determinations at *p*H higher than 8·2 on account of

absorption of carbon dioxide from the air, which rapidly decreases the *p*H. In the experiments described here it has been possible partly to avoid these difficulties by using carbonate-bicarbonate buffer mixtures.

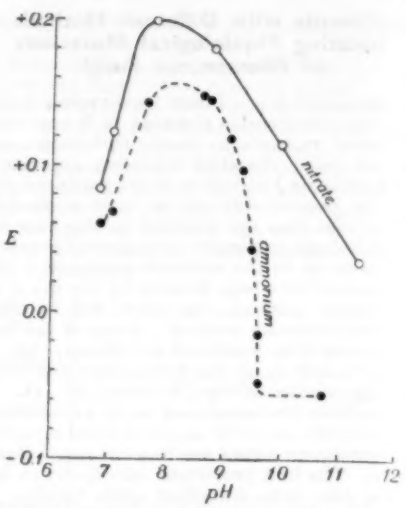
A sterile single cell culture of *Scenedesmus quadricauda* (Turp.) Bréb. has been used. The basic nutrient solution consisted of: $NaNO_3$, 300 mgm.; Na_2CO_3, 2,410 mgm.; K_2HPO_4, 11·2 mgm.; $MgSO_4.7H_2O$, 50 mgm.; $Ca(NO_3)_2.4H_2O$, 30 mgm.; ferric citrate, 2·7 mgm.; citric acid, 2·7 mgm.; $MnSO_4.5H_2O$, 0·05 mgm.; glass distilled water, 1,000 ml. Growth was measured photometrically, and expressed in extinction values. 0·001 *E* corresponds to some 10 cells per μl. The cultures have been inoculated by material cultivated for four days in this solution, after 50 ml. of 0·544 *N* hydrochloric acid per litre had been added, thus depressing the *p*H from 11·1 to about 7·5. This solution was centrifuged, and the cells were washed in sterile water, after which they were used for inoculation. The cultures were illuminated by a 500-watt incandescent lamp and a mercury vapour lamp, HgH 1,000, together giving a light intensity of 2,200 lux. The temperature was 25° C.

In the experiments the Algæ were cultured in Jena glass tubes with 10 ml. of solution in each. The *p*H of the basic solution was regulated by adding carbon dioxide to the gaseous phase of the tubes, which were then immediately closed by rubber stoppers, sealed with paraffin. The carbon dioxide was added at about 15 mgm./min. The tubes were shaken for two hours, and then the *p*H was measured of two of the (usually) four parallel tubes which had been treated with carbon dioxide for the same time. The other two tubes were illuminated for 20 hours and then *p*H was determined. From the two *p*H-determinations it was possible to compute the consumption of carbon dioxide during growth, making allowance for the increase in alkalinity that followed from nitrate assimilation, and which was determined as 0·2 milliequivalents per litre at a growth of 0·1 *E*.

From several determinations one gets the value of 2·27 ± 0·05 mgm. carbon dioxide consumption per tube at a growth of 0·1 *E*, which corresponds to 0·62 mgm. of carbon. According to my observations, this growth corresponds to 0·856 ± 0·007 mgm. of dry substance, which will consequently contain about 70 per cent of carbon, indicating that fats constitute a great part of it.

From these experiments we get the continuous curve in the accompanying graph. The abscisse are the mean values of the *p*H-determinations before and after growth, which never differed more than 1·1–1 *p*H, usually less. In another experiment the dipotassium hydrogen phosphate was omitted from the nutrient solution, and the same growth curve was then obtained. This shows that the cells have accumulated enough phosphate for optimal growth during 20 hours under these experimental conditions, and that the slight turbidity from precipitated phosphates, obtained at the highest *p*H-values, is without influence upon growth.

If ammonium is given to the Algæ instead of nitrate, the discontinuous curve in the graph is obtained. The two sets of experiments were inoculated with the same number of cells, and the amounts of nitrate and ammonium were equivalent. The growth in nitrate is always superior, but at *p*H 9·5 the growth in ammonium falls very rapidly, and at a higher *p*H, where the concentration of free



GROWTH OF *Scenedesmus quadricauda* AT VARIOUS *p*H VALUES WITH NITRATE AND AMMONIUM AS SOURCES OF NITROGEN

ammonium hydroxide rises, chlorophyll is destroyed, thus causing a decrease in absorption of light. Both in the case of nitrate and ammonium, *p*H rises during growth, according to the consumption of carbon dioxide, but somewhat less in ammonium than in nitrate.

A preliminary experiment indicates that growth is depressed more by high concentrations of carbon dioxide and CO_3^{--} than by HCO_3^-, and that the maximum of the curves depends on these conditions.

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Dec. 13.

Use of 'Gammexane' Dust against Domestic Cockroaches

MOGADISHU, capital of Somalia (ex-Italian Somaliland), is seriously infested with three species of domestic cockroach, which Dr. B. P. Uvarov of the Anti-Locust Research Centre has kindly identified for me as *Periplaneta americana* (L.), *Blattella germanica* (L.) and *Supella supellectilium* Serv. Almost all houses contain a sufficient number to cause frequent damage to fabrics and tainting of food and cupboards. Constant cleaning or spraying with pyrethrum or D.D.T. produced poor results, and it was decided to attempt control with 'Gammexane' dust. I am indebted to Mr. D. E. Kevan of the Department of Agriculture, Kenya, for suggesting this method to me.

The 'Gammexane' dust was as supplied for use in locust bait, and contained 10 per cent of 'active ingredient'. It was applied with a simple hand-duster which delivered a strong fine jet of dust. During the day-time the cockroaches sheltered mainly on the shaded undersides of horizontal surfaces, such as shelves in cupboards, and the dust was, therefore, only applied to such places and behind articles of furniture. The results far exceeded expectations. Immediately after dusting, the insects showed signs of distress, and most of them left their hiding-places

and ran up the walls. Within an hour many were unable to stand, and after twelve hours all *P. americana* were dead or dying, except the largest specimens, and the latter were incapacitated and died later.

Several premises were treated with the same results; but the kill was poor if the dusting was done at night-time, presumably because the insects had left their hiding-places and were generally distributed.

The dust did not affect the eggs, but for a few days after treatment dead first instar nymphs were found; this indicates that there was some residual effect. The eggs of *B. germanica*, which are carried by the females in the oothecæ until they hatch, were swept up with the dead bodies, and could be destroyed by burning. It seems unlikely, however, that nymphs from such eggs would survive, as their first food would presumably be the 'Gammexane'-coated bodies of dead cockroaches. The eggs of the other two species remained behind in the oothecæ attached to the hiding-places, and some of these ultimately produced nymphs that survived. It was, therefore, found advisable to dust again after an interval of three or four weeks.

Premises so treated remained reasonably free of cockroaches for about three months; but they were gradually re-invaded, and after three months it was again possible to find the insects in fair numbers.

It was found that 250 c.c. of dust was an adequate dose for one dusting of a house or flat containing a kitchen and four other rooms, and that this gave the required kill without leaving a noticeable deposit of dust. During dusting, the operator suffered temporary discomfort from irritation of the nostrils and throat, but no after-effects were observed. Treatment produced an unpleasant smell that lasted for about two hours, but in cupboards, etc., the smell lingered for a few days. It was, however, generally considered to be far less unpleasant than the smell of the insects.

This note has been written in the hope that it may be of use to residents in cockroach-infested places, and because it is considered that the method is worthy of further investigation which I am unable now to undertake.

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Dec. 24.

Nuclear Magnetic Resonance at Low Temperatures

Measurements of radio-frequency absorption and dispersion due to nuclear magnetic resonance have been made at liquid hydrogen temperatures using the same experimental arrangement as described in a recent note[1]. We have observed very strong resonant effects due to the protons in liquid and solid hydrogen. On account of the increased Boltzmann factor, the signals were considerably greater than those obtained with substances at room temperature, and were several thousand times the noise voltage. There appeared to be no appreciable change in the phenomena on solidification of the hydrogen. In agreement with the conclusions of Lasarew and Schubnikow[2] from their experiments on the susceptibility of solid hydrogen, we find the relaxation time for nuclear orientation to be less than one second. The absorption line was very sharp, and we estimate the width to be less than 0·5 gauss (2 kc./sec.).

A number of other nuclei have been investigated at liquid hydrogen temperatures. In lithium fluoride both the lithium and fluorine resonance were observed. Neither of these resonances could be detected in this compound at room temperature. Observations on lithium chloride failed to reveal the lithium resonance. A resonance was obtained for sodium in sodium fluoride but could not be found in sodium chloride. The fact that a resonance cannot be observed may be either because the relaxation time is very long or because there is exceptional broadening of the line by spin-spin or spin-lattice interaction. In the latter case it may be possible to obtain measurable effects by working at still lower temperatures and, in order to test this, experiments are now in progress at liquid helium temperatures.

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J. Hatton

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Dec. 20.

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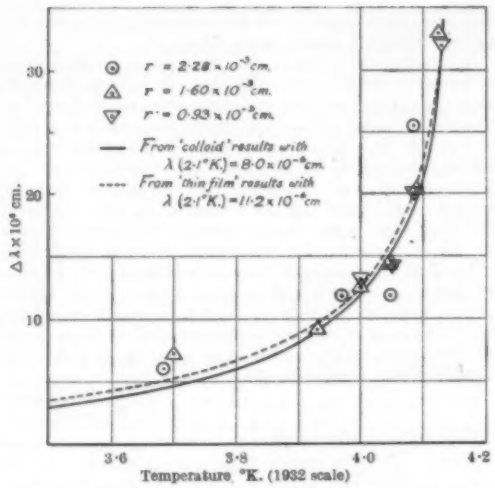
Penetration of Magnetic Field into Superconducting Mercury

It is well known that a magnetic field is almost completely excluded from a superconductor, so that a long cylinder has a diamagnetic susceptibility χ_0 which is $1/4\pi$ for a field parallel to the cylinder axis, or $1/2\pi$ for a transverse field. The magnetic field does, however, penetrate slightly, so that the actual diamagnetic susceptibility χ should be slightly smaller than χ_0, and elementary considerations show that we should have

$$\chi/\chi_0 = 1 - 2\lambda/r, \qquad (1)$$

where λ defines a 'penetration depth' and r is the cylinder radius. Previous experiments by one of us[1] on colloidal mercury, and by Appleyard and others[2] on thin mercury films (in both cases involving specimen size comparable to or smaller than λ), showed that λ is of the order of 10^{-5} cm. and increases several times as the temperature approaches the transition point (4·17° K.). Thus χ for cylinders with radii of order 10^{-3} cm. should vary by a few per cent close to 4·17° K.

We have made accurate relative measurements of χ on three specimens: (*a*) a mercury-filled glass capillary (length 28·9 cm., radius $2{\cdot}28 \times 10^{-3}$ cm.) wound into a spiral so that it is effectively a long cylinder transverse to the field; (*b*) a bundle of 98 mercury-filled capillaries of mean length 1·83 cm. and mean radius $1{\cdot}62 \times 10^{-3}$ cm., with the field parallel to the cylinder axes; and (*c*) a bundle similar to (*b*) but containing 198 capillaries of mean length 1·83 cm. and mean radius $0{\cdot}93 \times 10^{-3}$ cm. The method of measurement was an improved version of that used in the colloid work, and relative values of χ could be measured with an accuracy of about 0·25 per cent in fields as small as 5 gauss with only 10^{-3} c.c. of mercury (absolute values could be only roughly measured, since the volume of mercury was not very accurately known, and for other reasons). Changes of χ with temperature of the expected order of magnitude were found, which varied with r as


r = 2·28 × 10⁻⁵ cm.
r = 1·60 × 10⁻⁵ cm.
r = 0·93 × 10⁻⁵ cm.
From 'colloid' results with λ (2·1° K.) = 8·0 × 10⁻⁵ cm.
From 'thin film' results with λ (2·1° K.) = 11·2 × 10⁻⁵ cm
Δλ × 10⁵ cm.
30
20
10
3·6
3·8
4·0
4·2
Temperature °K. (1932 scale)

predicted by equation (1), and from the results the variation of $\Delta\lambda = \lambda - \lambda\ (2{\cdot}1°\ \mathrm{K.})$ with temperature shown in the accompanying graph was deduced.

The experimental points agree within the limits of experimental error both with the curve deduced from the colloid work (in which only relative values of λ were accurately measured) if λ (2·1° K.) is chosen to be $0{\cdot}80 \times 10^{-5}$ cm., and with the curve deduced from the thin-film results if λ (2·1° K.) is chosen to be $1{\cdot}12 \times 10^{-5}$. It has been pointed out by Ginsburg[3] that if the surface-energy per unit area, α_n of normal mercury, is appreciably different from α_s, that of superconducting mercury, the thin-film experiments (in which only critical fields were measured) should yield not λ, but $\lambda + \beta$ where $\beta = 8\pi\ (\alpha_n - \alpha_s)/H_c^2$ (H_c is critical field). If then both the colloid and the thin-film results are exactly correct, we can deduce, with the help of the present experiments (which enable the hitherto unknown absolute values of λ of the colloid work to be estimated), that β is of the order $0{\cdot}4 \times 10^{-5}$ cm., and, moreover, that β varies only slightly with temperature. Unfortunately, however, the accuracy of neither the colloid nor the thin-film work is sufficient to make this interpretation of their slightly different results certain, and until more accurate data are available this estimate of β can be regarded only as an upper limit.

Our confirmation of equation (1) is interesting in view of the doubt cast on its validity by experiments of Casimir[4], in which essentially equation (1) was tested for r of order 0·7 cm. by an A.C. method. Casimir found that λ did not appear to vary with temperature by nearly so much as the earlier work predicted, and it seemed that perhaps the same parameter λ could not be used both for $r \gg \lambda$ and $r \gtrsim \lambda$. The present experiments show that such an assumption is unnecessary and suggest that some source of error may have been present in Casimir's experiment. Prof. Casimir has been kind enough to inform us that he has recently found such a possible source of error. The varying bath pressure, acting on the evacuated tube on which the measuring coils were mounted in his experiment, may have caused these coils to expand as the temperature was reduced; he finds from a rough estimate of this effect that it is of the right order of magnitude to remove the disagreement.

A fuller account of this work will be published elsewhere.

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Dec. 16.

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Emission of Secondary Electrons from Nickel and Molybdenum by Neutral Atoms of Mercury and Potassium

We wish to describe briefly some experiments with high-speed neutral atoms produced by the neutralization of positive ions. A homogeneous beam of neutral atoms of mercury, with varying energy, was produced by a method devised by Oliphant[1]. The fast mercury ions which were pulled out of a hot cathode mercury arc were made to pass through a narrow metallic canal, where a large fraction of them collide with its walls almost at grazing incidence and are neutralized but retain their initial speed. The residual positive ions were filtered out of the mixed emergent beam by an electrostatic field applied between two plates placed beyond the canal.

Neutral atoms of potassium were produced by passing an accelerated beam of potassium ions through potassium vapour, where they are neutralized by 'electron exchange' but retain their original kinetic energy. The residual positive ions were filtered out from the beam as in the previous case. These beams of neutral atoms, ranging in energy from 1,200 to 2,500 volts for mercury and from 1,200 to 2,000 volts for potassium, were made to fall on a metal target; under these conditions, the neutral beam ejects electrons both from nickel and molybdenum targets.

The secondary emission, which rises almost in proportion to the energy over the range studied, is greater for a dirty target surface than for a well-degassed one. The energy distribution of the electrons is in all cases Maxwellian, corresponding to the effective temperatures listed below for typical conditions:

Mercury atoms of energy 1,500–2,500 volts	
Undegassed nickel	40,000–45,000° K.
Degassed nickel	29,000–34,000° K.
Undegassed molybdenum ..	40,000–45,000° K.
Degassed molybdenum ..	30,000–33,000° K.
Potassium atoms of energy 1,200 volts	
Undegassed molybdenum	35,000° K.
Degassed molybdenum	29,000° K.

It was observed that some of the incident atoms were scattered from the target and were able to release secondary electrons from neighbouring metal electrodes. More mercury atoms were scattered by a dirty molybdenum surface than by a clean one, but the reverse was found with potassium atoms.

The details of this work will be published at a later date.

We wish to express our sincere thanks to Prof. M. L. Oliphant for his helpful advice and encouragement throughout the work.

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Self-Recovery of Metals

In two recent communications in *Nature*[1,2], evidence from X-ray photographs was given on the annealing of filed copper powder at room temperature. Similar observations of other investigators were also mentioned (the authors, however, omitted to mention the detailed investigation on the self-annealing of rolled copper by M. Cook and T. Ll. Richards[3]). Further, attention was directed to the marked effect of impurities on the rate of self-recovery and recrystallization.

It may be remarked that observations closely related to those reported in these communications were made several years ago by other investigators. In this connexion in particular, the experiments of Calvet, Trillat and Paič[4] with aluminium of the highest degree of purity may be mentioned. For example, it was found by these investigators that severely rolled aluminium of 99·9986 per cent purity shows recrystallization, as indicated by the appearance of sharp interference spots, according to the following table:

Temperature		Time of recrystallization		$T_R \log_{10} 4\nu t$ ($\nu = \sim 5 \cdot 6 \times 10^{12}$)
			sec.	
0° C.	$T_R = 273°$ K.	$\geqslant$ 48 days	$t = \geqslant 4{,}150{,}000$	$\geqslant 5500$
25	298	$>$336 hr.	$>1{,}210{,}000$	>5840
40	313	~40 hr.	~ 144,000	~5840
60	333	6 hr.	21,600	5940
100	373	1 min.	60	5700
150	423	5 sec.	5	6000

In the last column we give the values of $T_R \log_{10} 4\nu t$, where T_R is the temperature (in ° K.) and t the corresponding time of recrystallization, and ν the characteristic frequency for aluminium. The approximate constancy of this expression shows that the recrystallization at all temperatures follows Van Liempt's "law of corresponding states of recovery"[5], according to which corresponding times and temperatures of recrystallization (or recovery) are connected by a formula of type:

$$\nu t \exp -S/kT_R = \text{const. (with log const.} \ll \log \nu t),$$

in which S represents the activation energy for interchange of atoms. The fact that T_R and t satisfy this 'law' means that the self-recovery at room temperature is not essentially different from that at higher temperatures, only its velocity is correspondingly smaller. A similar conclusion was reached by Cook and Richards (loc. cit., p. 169). As to the enormous influence of small amounts of impurities on the course of the recovery, it follows from Calvet's experiments that its rate in rolled aluminium with 99·996 per cent metal is *at least* 2,000 times as slow as in the 99·9986 per cent metal at the same temperature (100° C.).

I have published detailed considerations of these phenomena elsewhere[6].

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[1] Reyen, L. L. van, *Nature*, **157**, 371 (1946).
[2] Miller, J. L., Bannister, L. C., and Hinde, R. M., *Nature*, **158**, 705 (1946).
[3] *J. Inst. Metals*, **70**, 159 (1944).
[4] Calvet, J., Trillat, J. J., and Paič, M., *C.R. Acad. Sci., Paris*, **201**, 426 (1935). Calvet, J., *C.R. Acad. Sci., Paris*, **200**, 66 (1935). Trillat, J. J., *Metal Industry*, **49**, 27 (1937).
[5] Liempt, J. A. M. van, *Rec. Trav. Chim. Pays-Bas*, **53**, 941 (1934); *Z. anorg. allg. Chem.*, **195**, 366 (1931); *Z. Phys.*, **96**, 534 (1935).
[6] Burgers, W. G., "Rekristallisation, Verformter Zustand und Erholung", "Handbuch der Metallphysik", III, 2 (Akad. Verlagsgesellschaft, Leipzig; Edwards Brothers, Inc., Ann. Arbor, Michigan, 1944), §§ 77, 79, 150 and following.

Application of Similarity Principles to Thermal Transport Systems

The use of similarity laws is well established for mechanical transport systems, that is, systems in which the dependent variable (A) is the flow or transport of matter. Examples of dimensionless numbers (B) used in such systems are the Froude number for mechanical systems depending solely upon the action of gravity, the Reynolds number (R_e) for mechanical systems depending upon the action of viscosity, and the number introduced by Davis[1] for systems depending upon the action of density changes in hot gases. Although heat transfer is involved in the last of these three examples, it is really a mechanical system, since the heat is conveyed by the mechanical motion of the fluid concerned. The applicability of model results expressed in the form $A = f(B)$ to the original system is based upon the fact that the motion of any element of the fluid obeys the fundamental law of dynamics, $p = mf$, even though the integration of this law for the three-dimensional extended system is too complex for mathematical treatment.

When heat is transferred not by mechanical movement of a fluid but by conduction or radiation, it is often equally impossible to integrate the fundamental laws throughout the three-dimensional system. An example of great practical importance is the transfer of heat by radiation from a flame which changes temperature appreciably as it flows along a furnace system. In such a case, two transport processes are at work: (i) the mechanical flow of gas along the system coupled with energy release by combustion; (ii) thermal transport by radiation from the flame to the surroundings. The dependent variable is the distribution of heat transfer as a function of position along and across the furnace, so that a typical dimensionless criterion of it is the ratio $A = H_n/H_1$, where H_n is the heat transfer per unit area and time at a general section of the surface n, and H_1 that at a standard section, say, that under the centre of the flame.

Since Rummel[2] has shown that the release of energy by combustion in a diffusion flame is purely governed by considerations of gas mixing, the dimensionless criterion for the first transport process is the Reynolds number R_e. This is not, however, a sufficient criterion of similarity since, for example, if the radiation temperatures are very different in the model and in the original, the gas will not in general be cooled by radiation by the same amount in the same proportional distance even though the proportional flame-lengths are made the same by using the same Reynolds numbers. We have, therefore, to express the model law in the form

$$A = f(R_e, N),$$

where N is a suitable thermal transport criterion which must be given the same value in model and original before the model results can be generalized to the full-scale furnace with complete confidence.

In order to find what is the characteristic number N for thermal transport, we have to find a law analogous to Newton's first law of motion, $p = mf = d(mv)/dt$, which expresses the rate of change of momentum of the elementary unit of the system. In the case of thermal transport, the analogous quantity expressing the thermal *vis impressa* is clearly the time-rate of heat transfer H. Now just as in mechanical similarity theory the general force p

is replaced by the special kind of force law involving a physical coefficient such as the viscosity, so here the driving force must be measured by a law such as

$$H = K\,\frac{T_a - T_b}{D} \quad \text{for conduction} \qquad (1)$$

$$\text{or } H = \sigma E\,(T_a^4 - T_b^4) \quad \text{for radiation: finite temperature difference} \qquad (2)$$

$$\text{or } H = 4\sigma E T_1^3 \delta T \quad \text{for radiation: small temperature difference} \qquad (2a)$$

(K is thermal conductivity of conductor; D is thickness of conductor; σ is Stefan's constant; E is combined emissivity of flame and surroundings; T_a, T_b are temperature of flame and surroundings, °K.)

It follows that in cases where, for example, radiation is the dominant factor, the model law is that the dimensionless number N is given by

$$N = \frac{H}{\sigma E\,(T_a^4 - T_b^4)}; \qquad (3)$$

and must have the same value in the model and in the original. If T_a/T_b is the same in model and original, N can be written

$$N = \frac{H}{\sigma E\,(\theta^4)}, \qquad (4)$$

where θ is the absolute temperature of any portion of model and original. This means that the temperature of the model system, the emissivity of the flame and the linear scale can be changed provided the total rate of heat input (HL^2) is adjusted to give the factor N the same value as in the original system. The model must, of course, be geometrically similar, and the heating gases must burn in a way which is geometrically similar to that of the original system. Clearly, also, the absolute temperatures T_a and T_b must be in the same ratio in the model and the original, unless T_b^4 is negligible compared to T_a^4.

If the working temperature of the model is governed by refractory considerations and its linear dimensions by economic ones, it will not in general be possible to have both R_e and N the same in the model and in the original. Hence it is necessary either to decide whether combustion flame-length or heat-loss cooling of the flame gases is the more important factor for model investigation, or else to make a departure from perfect geometrical similarity such as to give R_e and N the correct values. Thus by using two different length-scales on the model, one for the area of the gas and air inlets (to give correct R_e at the flame inlet) and the other for the combustion chamber (to give correct N), both flame-length and gas cooling can be given the correct proportional values. This is analogous to the use of different horizontal and vertical scales in tidal models.

It should be noted that the formulation of the law of heat transfer in a way analogous to the $p = mf$ equation enables the rate of entropy *increase* dS/dt, or of 'virtue' degradation[3], dV/dt, of the system to be evaluated. Thus

$$\frac{dV}{dt} = \frac{(T_a - T_b)^2}{T_a \times T_b} \times \frac{1}{\rho D} \qquad (5)$$

holds for the conduction law. We have, therefore, a numerical connexion between entropy and time as a special case of the general connexion referred to by Eddington[4].

It is hoped in a later communication to give a more detailed examination along these lines of the work carried out by my colleagues[5] on a model open-hearth furnace.

M. W. Thring
British Iron and Steel Research Association,
London. Dec. 4.

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Surface Tension of Nuclear Matter and the Enumeration of Eigenfunctions of an Enclosed Particle

The enumeration of eigenfunctions for a bounded continuum to a closer approximation than the Rayleigh asymptotic expression has, in recent years, largely because of its significance in problems of room-acoustics, received considerable attention[1]. The number of eigenfunctions with their wave-numbers equal to or less than K is given by

$$a(K) = g\left\{\frac{4\pi V}{3}K^3 + \theta\frac{\pi S}{4}K^2 + \frac{L}{8}K + O(K)\right\}, \qquad (1)$$

where the value of θ depends on the boundary condition which the eigenfunctions (U) have to satisfy; $\theta = -1$ when U vanishes at the boundary, and $\theta = +1$ when $\partial U/\partial n$ (n being the normal to the surface) vanishes at the boundary. We could contemplate other possible boundary conditions for which θ could take values between -1 and $+1$. V is the volume of the enclosure, S its surface area, and L has the dimension of length, which for a rectangular enclosure is the sum of the edge-lengths. That the volume term is independent of the shape of the enclosure was shown by Weyl (1911); for the surface term this is assumed, but a demonstration is lacking. The L-term is still more uncertain. (The order term $O(K)$ is probably of order less than $K^{3/2}$.) The effect of retaining the surface term in equation (1) on Stefan's law of radiation and on Debye's theory of specific heat was dealt with by one of us (D. S. K.) and has also been recently treated by Brager and Schuchowitzky[2]. They have further derived, by applying (1) to a completely degenerate electron gas, the following expression (assuming one free electron per atom) for the surface tension of metals,

$$\sigma = \alpha(\rho/A)^{4/3} \text{ dyne cm.}^{-1}; \quad \alpha \sim 5{\cdot}6 \times 10^4, \qquad (2)$$

where A is the atomic weight and ρ (gm. cm.$^{-3}$) the density of the metal. It is interesting to observe that the above equation, but with the value of α reduced by a factor of about $\frac{1}{3}$, was obtained on certain assumptions from the electron theory of metals by Gogate and Kothari, jun.[3], who found the equation in reasonably good accord with experiment; the experimental values of ρ, σ give α as about $2{\cdot}2 \times 10^4$.

In the present note, we examine the effect of the surface term in (1) on the statistical properties of nuclei, adopting the free-particle model (neutron-proton gas). It is somewhat remarkable that an elementary straightforward calculation (involving no assumptions about nuclear forces, the calculation being based on the free particle model) gives for the surface-dependent term of nuclear energy the value

$$G = \Gamma A^{2/3},$$

where A is the mass number of the nucleus, and Γ is about 20 MV. The value of Γ as deduced from empirical data on nuclear binding energies is about 10 MV.

For a completely degenerate ideal Fermi–Dirac gas, we obtain from (1)

$$\sigma = \frac{g\pi}{16}\frac{h^2}{m}\left(\frac{p_0}{h}\right)^4, \qquad (3)$$

where p_0 is given by the cubic equation

$$\left(\frac{p_0}{h}\right)^3 - \frac{3S}{16V}\left(\frac{p_0}{h}\right)^2 - \frac{3n}{4\pi g} = 0; \qquad (3a)$$

p_0 is the maximum momentum characterizing the Fermi distribution, n is the number of particles per unit volume, m the mass and g the weight-factor of a particle: σ is the surface tension. In the case of metals the second term in (3a) is negligible, and (3) reduces (taking m = electron mass, $g = 2$) to

$$\sigma = \frac{g\pi}{16}\frac{h^2}{m}\left(\frac{3n}{4\pi g}\right)^{4/3} = 5{\cdot}6 \times 10^4\ (\rho/A)^{4/3}.$$

In the case of nuclei, the second term in (3a) is also significant. The values of Γ, taking m as the mass of a nucleon and $g = 4$ (as the number of protons and neutrons are nearly equal, we may regard the nucleon gas as consisting of similar particles, A in number, with $g = 4$), are given below for different values of A.

$\Gamma = 4\pi r_0^2\sigma$; $(r_0 = 2{\cdot}05 \times 10^{-13}$ cm.)

A	20	100	200	∞
Γ (MV.)	48·5	27·5	23·5	13·4

The applications of (1) to a Bose–Einstein gas (liquid He II), where the surface tension becomes negative, to the dependence of magnetic properties on surface area and other allied problems will be treated elsewhere.

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Nov. 28.

[1] Bolt, R. H., *J. Acous. Soc. Amer.*, **10**, 228 (1939). Husimi, K., *Proc. Physico-Math. Soc. (Japan)*, **21**, 759 (1939). See also Morse, P. M., and Bolt, R. H., *Rev. Mod. Phys.*, **16**, 69 (1944). (The lattice points corresponding to $\rho^2 = n_1^2 + n_2^2 + n_3^2$ have been tabulated by Gupta, H. R. (*Proc. Nat. Inst. Sci. India*, in the press) for $\rho < 100$.)

[2] Kothari, D. S., *Science and Culture*, **6**, 246 (1940); *loc. cit.*, 247. Brager, A., and Schuchowitzky, A., *J. Chem. Phys.*, **14**, 599 (1946). In discussing the effects of surface area on specific heat of dispersed liquids (sprays) account must also be taken of capillary (surface) waves.

[3] Gogate, D. V., and Kothari, D. S., jun., *Phil. Mag.*, **20**, 1136 (1935).

Elements of Atomic Numbers 43 and 75

Prof. F. A. Paneth and also Prof. E. Segrè have directed attention (*Nature*, January 4, p. 8 and p. 24) to the unconfirmed claim by I. and W. Noddack to the discovery of element 43 which they named 'masurium'[1]. Apart from a fantastic patent specification[2], they brought forward no chemical evidence to show that they had discovered this element.

It will be recalled that the Noddacks (Mrs. Noddack was then Dr. Ida Tacke) claimed to have found elements 43 and 75, Mendeléef's eka- and dvi-manganese, in columbite and platinum ores. Their claim was disputed at the time by Prandtl[3] and by Zvjagintsev[4] and others. Eventually, however, Feit[5] isolated about a pound of potassium perrhenate (dvi-manganese was called 'rhenium' after Germany's 'Westmark') from molybdenum waste, and from this salt the new element was isolated. The Noddacks' claim was therefore accepted, although since then no reference has been made to any masurium or rhenium having been isolated from either columbite or platinum ores.

Meanwhile, Loring and Druce[6] discovered traces of dvi-manganese in crude manganese salts; Heyrovský and Dolejšek also reported the same discovery[7]. Loring had been looking for 'missing elements' since 1922, and in particular was seeking an element with higher atomic number than uranium. When the Noddacks published their claim, it was decided to publish what evidence there was of the presence of manganese congeners in its ores and crude salts. Soon after, Loring suggested[8] that dvi-manganese would be found associated with molybdenum. It was duly shown that molybdenum glance was the richest known source of this element, thus opening the way for Feit's work.

Loring, who died in 1944 from air raid injuries, intended to call the new element 'londinium' had not the name rhenium apparently been accepted. The name 'technetium' is now proposed for element 43. Will the validity of the claim of rhenium be re-examined in the light of all the evidence?

Gerald Druce

Battersea Grammar School,
London, S.W.16.
Jan. 6.

[1] *Naturwissen.*, **13**, 567 (1925).
[2] English Patent 317,035, Feb. 27, 1928.
[3] *Z. angew. Chem.*, **39**, 1049 (1926).
[4] *Nature*, **117**, 622 (1926). *Z. angew. Chem.*, **40**, 256 (1927).
[5] *Z. angew. Chem.*, **43**, 459 (1930).
[6] *Chem. News*, **131**, 273 and 337 (1925).
[7] *Nature*, **116**, 782 (1925); **117**, 16 and 159 (1926); but see also **135**, 870 (1935).
[8] *Chem. News*, **133**, 276 (1926).

Study of Ocean Swell

The apparatus for the analysis of waves already described in *Nature*[1] has been used to form spectra of a long series of wave observations made at Pendeen and Perranporth on the north-west Cornish coast.

Comparison of the spectra with the meteorological charts of the North Atlantic shows that the swell arriving from a distant storm shows a more or less narrow band of periods, the minimum period of which decreases with time, in a manner which is consistent with the assumption that the swell travels from the generating area to the coast with a velocity equal to the classical group velocity appropriate to its period on arrival. In one example it is possible to show that the velocity of propagation does not differ by more than five per cent from the theoretical group velocity.

The observations in general suggest that the longest period exhibited by swell due to a distant storm is proportional to the maximum wind velocity in the storm, and does not depend upon the fetch or duration of the wind. This rule may have to be modified in studying generating areas of small size.

The swell is observed to travel great distances. Low swell has been received from a tropical storm off the coast of Florida, 2,800 miles from Cornwall, and from a storm near Cape Horn between 6,000 and 7,000 miles from Cornwall.

It is hoped to publish these results shortly, on behalf of the members of this research group.

N. Barber
F. Ursell

Admiralty Research Laboratory,
Teddington.
Jan. 25.

[1] *Nature*, **158**, 329 (1946).

SIGNIFICANCE OF TRACE ELEMENTS IN PLANTS AND ANIMALS

THE significance of the presence of trace elements in plants and animals was discussed at a meeting of the Association of Applied Biologists held at the Imperial College of Science and Technology, London, on October 4.

Sir Edward Salisbury, in a brief general introduction, said that he was glad to be present because he had played a part in starting and integrating a series of investigations of mineral deficiencies under the Agricultural Research and Improvement Councils. It may not be generally realized that the crowded plants in a field of wheat are subject to competition and therefore to various deficiencies, which are enhanced if weeds are present. He pleaded for the researches to be pursued along broader lines than immediately practical ones. As an example, he mentioned the weeds that are known to be efficient in extracting manganese from the soil, and raised the question whether the next crop would benefit from the decomposition of such weeds, or would the deficiency be enhanced as a result of the depletion of the soil of its reserves of available manganese.

Prof. T. Wallace, Long Ashton Research Station, University of Bristol, dealt with the visual diagnosis of mineral deficiencies. The applicability of the method depends on the fact that plants which are deficient in any mineral nutrient develop well-defined and characteristic signs of the shortage in various organs, particularly in the leaves. To provide a basis for using the visual method on crop plants, it is necessary as a first step to produce the visual effects in the various crops and to record the results in a suitable manner. This is done by growing plants under controlled conditions of nutrient supply, usually in sand cultures, to produce the various effects, and afterwards checking the results under field conditions. The visual effects are suitably recorded as colour photographs, the negatives of which can be preserved without appreciable deterioration for several years.

In applying the method to field crops, cognizance is taken of soil conditions, such as texture, drainage, *p*H, dryness and cultural conditions, as the information is often helpful in ruling out certain deficiencies and in pointing to others. The presence of certain pests and diseases may complicate symptoms, and in extreme instances may even rule out the use of the method. Use is also made of indicator plants, that is, plants which are highly susceptible to particular deficiencies and also show characteristic signs of them, such as oats for manganese, sugar beet for boron, potatoes for potassium. Indicator plants may be used, combined with fertilizer and spray treatments, in special indicator plots to determine the likelihood of deficiencies occurring on land of unknown cropping potentialities.

The visual method has the great advantage of requiring no special equipment and is thus particularly suited to survey work, for which it has been widely used. It is also valuable in recording nutrient conditions in field experiments, especially with long-term crops such as fruit. Recently it has been successfully applied to the problem of resolving the injurious factors concerned in the failure of plants on acid soils.

For advisory purposes, visual diagnosis and the chemical tissue test method used together provide a very rapid and effective procedure for solving a wide variety of crop nutritional problems. Details of the method and its use in the field are given in Wallace's "The Diagnosis of Mineral Deficiencies in Plants" (with supplement 1944) (London: H.M. Stationery Office).

American workers have shown that qualitative chemical tests carried out on fresh plant material can be used in the study of fertilizer needs. A technique devised at the Long Ashton Research Station to test quantitatively a number of the easily soluble nutrients in fresh tissues within a short time was described by D. J. D. Nicholas. The method has been successfully used in the diagnosis of mineral deficiencies and toxicities in crop plants, and has served as an invaluable confirmatory test to the visual method. Its value as a diagnostic method is based on the fact that the extractable nutrients from healthy, as compared with unhealthy, plants usually show significant differences for the limiting mineral elements. In this way straightforward deficiencies of potassium, magnesium, calcium, phosphorus, nitrogen and manganese, and excess levels of manganese, chlorine and zinc can be readily confirmed in a short time. The tissue test method is being extended to include other trace elements.

The method involves a special field-sampling technique and preparation of test samples, followed by the extraction of the nutrients from the macerated tissues. Two reagents used for the extraction are (1) Morgan's reagent (glacial acetic acid buffered by means of sodium acetate at *p*H 4·8; this reagent is specially purified for the sensitive manganese test), (2) hydrochloric acid used in special instances for the extraction of iron and zinc.

The chemical tests used comprise well-known turbidity and colour tests, and assessment is made initially by eye. This enables the status of each element to be grouped into high, medium and low categories. These can be fixed more precisely by the use of the Lovibond comparator and standardized colour disks. Nutrient standards have been fixed for a range of economic plants, and a working knowledge of these is essential for accurate diagnostic work. Threshold values for deficiencies have been determined for the various nutrients, which generally coincide with the points of onset of visual signs of the particular deficiencies. In many instances tissue test values give a clue to an impending mineral deficiency or toxicity prior to the onset of visual signs.

A critical study has been made of the seasonal cycle of the extractable nutrients in a variety of crop plants grown under various manurial treatments, in order to determine critical sampling dates in the seasonal cycles of the various nutrient elements.

The correlations obtained between the tissue test results and the nutrient treatment, visual diagnosis and full chemical analysis of the foliage are good. On long-term manurial plots, soil analysis data are usually in accord with tissue test results; but survey work over wide areas has shown that agreement is not always close and further work is necessary.

The tissue test method has proved invaluable for rapid diagnostic work and has played an important part in resolving nutrient disorders in farm and garden crops. It should also be of value in ecological studies and in determining the distribution and translocation of nutrients in various plant organs.

The mineral-deficiency team at the East Malling Research Station, near Maidstone, Kent, the work of which was described by Dr. W. A. Roach, has concentrated mainly, but not exclusively, on leaf analysis and plant injection as preliminary methods of diagnosis. But to be of practical value a diagnosis must include a measurement of the effect of curative treatment on yield and quality of crop.

The analytical method is based on a comparison of leaves from unsatisfactory plants with corresponding leaves from plants that are satisfactory from the growers' point of view. At least six elements (iron, manganese, zinc, boron, copper and nickel) occurring in minute amount must be determined in the presence of relatively large amounts of the major nutrient elements. The special methods necessary for this purpose are being evolved. Plant injection methods make possible the treatment of a selected portion of a plant with any desired element, a similar neighbouring part being left untreated for comparison. The part may be of almost any size, from a single inter-veinal area of a leaf to a whole tree. The effect is seen in the course of a week or so.

The first big achievement of the injection method was to find a cure for various 'corky' troubles in apples. These caused the death of whole plantations in western Canada and rendered useless vast amounts of fruit there, in New Zealand and elsewhere. The proof by injection methods that the cause was boron deficiency led in a year to commercial methods of cure by spraying the trees and by applications to the soil. Serious deficiencies of copper in apple and pine trees in Australia and of manganese in cherries in Britain were diagnosed in a similar manner.

Plants are commonly deficient of more than one trace element at a time. Fruit trees in South Africa were deficient of both manganese and zinc. Many trees were dying and still more were barren. The cure of both deficiencies was necessary to restore the trees to full productivity.

Trace-element deficiency may not only accompany potassium deficiency, but also curing the trace-element deficiency seems sometimes to lead to a partial cure of the potassium deficiency, even without the addition of any potassium.

During the War, the methods were used for increasing the yields of arable crops. The cure of symptomless deficiencies of calcium and magnesium diagnosed in potatoes growing on freshly ploughed moorlands in Devon led to an increase of 3,000 tons of potatoes in the following season.

Multiple symptomless deficiencies of manganese, iron, zinc, boron, copper and nickel were proved to be of economic importance in the three crops tested, namely, potatoes, wheat and broad beans, in the marshlands of south Kent. The importance of complete diagnosis was illustrated by the fact that spraying potatoes according to diagnosis by symptoms, that is, with manganese, led to no increase in crop, whereas sprays containing manganese and zinc increased the crop from seven to eleven tons per acre, and spraying with all six elements diagnosed by injection led to still greater increases in crop.

The plant in absorbing essential mineral nutrients from the soil also takes up numerous other elements merely because they are brought into solution by the action of its roots, and since plant food is the basis of animal life, the same elements are found in animal tissues. Dr. H. H. Green (Veterinary Laboratory, Ministry of Agriculture, Weybridge) discussed trace elements in relation to the health of livestock.

If an element is found to be locally concentrated in some particular tissue, as, for example, iodine in the thyroid gland, the tendency is to assume a function for it, although it may be long before precise knowledge of that function is gained; but when the quantity of the element is not only exceedingly small but also is distributed throughout the tissues with no known sites of predilection, the impulse is to treat its presence as fortuitous until some instance of apparent absence is met in the form of an obscure deficiency disease, such as the 'pining' of lambs caused by lack of cobalt, or until the effects of unusual excess are shown in the form of a toxicosis such as the 'teart' of cattle in Somerset caused by excess of molybdenum.

Many of the trace elements found in living tissues are apparently inert; for example, nickel, although always present in soil-grown vegetation, does not appear to be an essential animal micro-nutrient, and relatively large amounts are harmless to animals. Some are important to plant physiology but of little consequence in animal economy. Boron is a limiting factor in plant health but, if essential for animal life at all, the smallest amounts ever found in plants are sufficient in the sense that no boron-deficiency disease has ever been recorded in animals. Zinc is certainly required by both plants and animals, and in the case of the latter it is the metallic component of the enzyme 'carbonic anhydrase' found in considerable concentration in the red blood corpuscles and other tissues; but the quantities in plant food exceed animal requirements, and no naturally occurring zinc-deficiency disease has been encountered.

With other trace elements the position is reversed, and their significance in animal physiology is much greater than in plant economy. Cobalt, if of any significance in plants at all, is required in such small amounts that a pasture may be growing luxuriantly and yet induce emaciation and death in grazing ruminants; while selenium can be tolerated by growing plants in amounts which are exceedingly harmful to animals consuming them.

Trace elements of proved economic importance are: iodine, copper, cobalt, manganese, selenium, molybdenum and fluorine. Lead and arsenic are neither biologically essential nor absorbed through plant roots in quantities injurious to animals. As for arsenic, the danger of cumulative poisoning is much exaggerated. Substantial sub-toxic doses repeatedly administered to sheep are rapidly eliminated, and the amounts naturally present in oysters and flat fish, although well above the limit sanctioned by health authorities concerned with arsenic as a food contaminant, are consumed without detriment to human health.

Prof. F. G. Gregory, of the Imperial College of Science and Technology, opened the discussion. He said that the work of the Research Institute of Plant Physiology on the subject under discussion fell between the field-work described by Dr. Roach and the very fundamental work of Dr. Hill. Use is being made of Dr. Roach's injection methods to provide material on which could be studied the effects of trace elements on various physiological functions of the plant. A start is being made with manganese and the potato, and results so far obtained are encouraging.

Dr. W. G. Ogg, of Rothamsted Experimental Station, said that his experience suggested that Dr. Roach's conclusion, that symptomless deficiencies of economic importance are common, might well apply to nine fields out of ten.

COAL UTILISATION RESEARCH IN GREAT BRITAIN

ON December 12, Mr. R. W. Foot gave the presidential address to the British Coal Utilisation Research Association, his last before the vesting date of the nationalization of the coal industry in Great Britain. This Association worked for eight years under the control of the Mining Association, which had contributed for maintenance during this period more than eight million pounds. The Mining Association had envisaged the development of a permanent institution, more particularly since the possibility of nationalization of the coal industry was recognized. In that event it was hoped that the National Coal Board would agree to take over the activities of the Association. In anticipation, and in order to prevent the slackening which might arise during a period of uncertainty as to the future, the Mining Association continued its financial support without reservation until the vesting day, January 1, 1947. The National Board has accepted the principle mentioned, and on that day stepped into the shoes of the Mining Association so far as the British Coal Utilisation Research Association is concerned, and was able to find the organisation in a state of full activity.

During its existence, most of which had been during a period of war, the Association concentrated on certain major operations of coal utilization. Mr. Foot, referring to the last three years, mentioned in particular the work of Mr. J. S. Hales on domestic coal-burning appliances—a subject touching almost every householder—and described it as a 'landmark' in space heating. So far as Great Britain is concerned, there is some justification for the term. In countries where colder conditions are common, people appreciate the advantages of dispersing available heat throughout their dwellings; in Britain, practice has led to the localization of warmth and its insulation from the rest. Efforts to cope with the effects have of necessity tended to be improvisations. The work of the British Coal Utilisation Research Association has shown how, by more rational design of domestic grates, the effective use of coal heat can be increased, and at the same time can be more widely dispersed through a dwelling. Such principles can be applied generally, and already appliances have been designed whereby a single unit fed by smokeless fuel can be made to serve a whole house. This may lead to a radical change in household practice.

On the industrial side, the use of coal in the generation of steam is the largest outlet, and was given pride of place. Priority was given to the so-called 'shell' boilers—the smaller fire-tube units in common use. Although everywhere in use, it was believed that familiarity had led to neglect in some respects; it was thought that carefully conducted research with modern resources would promote improvements in design and increases in efficiency. The work of a section of the Association under Dr. E. G. Ritchie has confirmed these anticipations. The larger water-tube boilers have been developed under more scientific conditions, mainly stimulated by the needs of electrical industry. In modern practice these encounter extremely severe conditions of operation. It has become a major problem to keep such plant in continuous service, owing to the destructive action of acid and other inorganic materials present in the products of combustion. The work of the Association has already made contributions to improve the 'availability' for service of large steam generators.

Mr. Foot referred to the 'down-jet furnaces', which arose from work done, during the War, on gas producers. It has led to the construction of a furnace, no bigger than a filing cabinet, but capable of producing per hour 200 lb. of steam at 200 lb. pressure. It is thought that such a furnace may enable solid fuels to be used to operate gas turbines.

The Association prosecutes a considerable range of more fundamental scientific work under the direction of Dr. D. H. Bangham. For all these branches there is now a staff of three hundred of all grades, under the control of the director, Dr. D. T. A. Townend. To provide for the necessary accommodation of all kinds, the Association is carrying out at Leatherhead a very extensive programme of building and equipment. It is planned to cope effectively with the great problems of coal utilization which the future promises to bring.

H. J. HODSMAN

CHEMOTHERAPY

THE Linacre Lecture, 1946, delivered by Sir Alexander Fleming, on "Chemotherapy, Yesterday, Today and Tomorrow" (Cambridge University Press, 1946. 2*s*.), has now been published. Opening his lecture with the warning that the title chosen was too ambitious and would require a series of lectures, Sir Alexander limited his remarks to chemotherapy of which he has had first-hand knowledge. He refuses to confine the meaning of the term 'chemotherapy' to the administration of chemical substances by way of the blood; he extends it to include any form of treatment which enables a chemical substance to exert directly an injurious effect upon bacteria. This definition includes antiseptic treatment, two cardinal principles of which are the avoidance of chemical substances which are too toxic to the host or to the tissues, and the effective diffusion of the therapeutic agent into the infected tissues. Discussing the antiseptic methods of Lister and the practice of asepsis which followed them, Sir Alexander demonstrates, by reference to experience gained during the First World War, how important it is that diffusion of the local chemotherapeutic agent into the infected area should occur and, by reference to the mode of action of Dakin's solution, how important is the drainage of the infected lesion by the exudation of fluid from it. Important also is the action of local chemotherapeutic agents upon the phagocytes which attack the bacteria. Sir Alexander's own work on this problem is well known, and he here shows how essential it is to consider the speed of action of the chemical substance on the bacteria and on the phagocytes respectively. If the phagocytes are killed by it before it kills or appreciably inhibits the growth of the bacteria, the tissues are left without one of their main means of defence.

Sir Alexander points out that scientific chemotherapy began with Ehrlich. He then discusses the aniline dyes, and thus comes to the sulphonamide of chrysoidine (prontosil), with which Domagk began the remarkable series of researches by many workers which have produced the sulphonamides now in use. The relative advantages and disadvantages of the sulphonamides are briefly indicated, and thus we come to the year 1940, when penicillin, discovered by Sir Alexander in 1928, four years before the first sulphonamide

was prepared and seven years before Domagk demonstrated the effective antistreptococcal action of prontosil, became available in sufficient quantity to enable practical therapeutical tests of it to be made. It is now well known how Sir Howard Florey and his collaborators in Oxford and in the United States made penicillin available and demonstrated its remarkable properties. It is, Sir Alexander says, the most powerful chemotherapeutic drug yet produced, for it will inhibit the growth of *Staphylococcus* even when it is diluted eighty million times. Adding still further to the discoveries of this fertile recent period, Sir Alexander outlines the properties of gramicidin and tyrothricin, obtained by Dubos in 1939 from a soil bacillus, *Bacillus brevis*, and those of streptomycin, obtained from *Streptomyces griseus* by Waksman in 1943.

Finally, Sir Alexander discusses briefly the possible chemotherapeutic developments of the future. This part of his lecture will perhaps disappoint those readers who expect dramatic prophecies; but, if they are disappointed, they have only themselves to blame, for no man could correctly forecast what may develop from the many possibilities opened up by recent work. Sir Alexander ends with a plea for the establishment of a central Institute of Microbiology, in which all the work now being done could be co-ordinated. The Royal Society called for the establishment of such an institute in 1945. If, says Sir Alexander, we had had such an institute in 1928, when he discovered penicillin but lacked the chemical facilities to develop his discovery, we could have had all the benefits of penicillin much earlier. A small fraction of the money spent upon our national medical, veterinary and agricultural services would endow such an institute. It would be difficult to conceive a project more essentially humane or a better long-term investment for the relatively small funds required.

G. LAPAGE

FORTHCOMING EVENTS

Monday, February 10

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.15 p.m.—Dr. H. W. Thompson: "Infra-Red Absorption Methods for Gas Analysis".

Tuesday, February 11

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (joint meeting with the FARADAY SOCIETY, at the Royal Society of Tropical Medicine, Manson House, 26 Portland Place, London, W.1), at 2.30 p.m.—Mr. G. Gee: "The Influence of Molecular Structure on the Elasticity and Tensile Strength of Rubber".

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. R. M. Chamney: "Development of Telephone Transmission over Lines in the last 40 Years".

ZOOLOGICAL SOCIETY OF LONDON (at Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. E. K. Rideal, F.R.S., and Dr. P. Johnson: "Colloids". (Subsequent lectures on February 18, 25 and March 4.)

ILLUMINATING ENGINEERING SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. J. S. Smyth: "The Brightness and Legibility at Night of Road Traffic Signs".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Short papers on "Fluorimetric Analysis".

SHEFFIELD METALLURGICAL ASSOCIATION (joint meeting with the REFRACTORIES ASSOCIATION OF GREAT BRITAIN and the SHEFFIELD BRANCH of the NATIONAL ASSOCIATION OF CLAYWORKS MANAGERS, at Mappin Hall, Sheffield), at 7 p.m.—Mr. W. T. Hale: "A Statistical Sampling Plan for Refractory Products".

Wednesday, February 12

INSTITUTE OF PHYSICS, LONDON BRANCH (at the Royal Institution, Albemarle Street, London, W.1), at 2.15 p.m.—Annual General Meeting. Symposium on "New Optical Materials".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Dr. F. A. Freeth, F.R.S.: "Economic Reconstruction; 3, Materials".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (joint meeting with the SHEFFIELD PHYSICAL SOCIETY, in the Physics Department, The University, Sheffield), at 5.15 p.m.—Dr. C. Sykes, F.R.S.: "Physics and Steel Making".

INSTITUTE OF PETROLEUM (joint meeting with the ROYAL AERONAUTICAL SOCIETY, at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. C. G. Williams: "Fuel and Lubricants for Aero Gas Turbines".

INSTITUTION OF ELECTRICAL ENGINEERS, TRANSMISSION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. G. T. Harwood: "The Operational Characteristics of Modern H.V. Wood-Pole Lines".

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. L. F. Pfeil: "Metals and Alloys for Service at High Temperatures".

TELEVISION SOCIETY (joint meeting with the BRITISH KINEMATOGRAPH SOCIETY, at Film House, Wardour Street, London, W.1), at 7.15 p.m.—Mr. Marcus F. Cooper: "The Film in relation to Television".

SOCIETY OF DYERS AND COLOURISTS, NORTHERN IRELAND SECTION (at the Queen's Hotel, Belfast), at 7.30 p.m.—Dr. T. Richardson: "The Abbot-Cox Process of Yarn Dyeing as Applied to Cotton".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Outlook in Psychology" (Speakers: Dr. E. B. Strauss, Dr. C. G. L. Pratt and Dr. J. Cohen).

MANCHESTER GEOLOGICAL ASSOCIATION (at the Manchester Geographical Society, 16 St. Mary's Parsonage, Manchester).—Dr. F. M. Trotter: "Structures in the North-Western Part of the South Wales Coalfield".

Thursday, February 13

CHEMICAL SOCIETY (in the Chemical Department, The University, Woodland Road, Bristol), at 2.15 p.m.—Discussion on "Protein Chemistry".

SOCIETY OF DAIRY TECHNOLOGY (at the Imperial Hotel, Temple Street, Birmingham), at 2.15 p.m.—Dr. S. K. Kon: "The Effect of Heat-Treatment on the Nutrient and Chemical Properties of Milk and Milk Products".

CHEMICAL SOCIETY (joint meeting with the SHEFFIELD UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. J. Monteath Robertson, F.R.S.: "Bond Lengths in Aromatic Hydrocarbons".

INSTITUTION OF ELECTRICAL ENGINEERS, INSTALLATIONS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. Widnall and Mr. R. Newbound: "Protective Finishing of Electrical Equipment".

INSTITUTION OF ELECTRONICS, N.W. ENGLAND SECTION (joint meeting with the MANCHESTER CENTRE of the ILLUMINATING ENGINEERING SOCIETY, in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Dr. H. Meyers and Mr. G. A. R. Tomes: "Recent Advances in Luminescent Materials for Electronic Devices".

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Members' Night—"Our Jobs and Problems".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Dr. H. Davis: "Some Chemical and Pharmaceutical Aspects of Anæsthesia".

ROYAL PHOTOGRAPHIC SOCIETY (joint meeting of the SCIENTIFIC AND TECHNICAL GROUP and the COLOUR GROUP), at 7 p.m.—Mr. Percy W. Harris: "Practical Colour Processes" ("How It Works in Colour Photography", 4).

SOCIETY OF DYERS AND COLOURISTS, WEST RIDING SECTION (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. H. P. Staudinger: "Polymer Chemistry".

CHEMICAL SOCIETY, MANCHESTER SECTION (joint meeting with the LOCAL SECTION of the ROYAL INSTITUTE OF CHEMISTRY, in the Chemistry Department, The University, Manchester), at 7.30 p.m.—Prof. M. Stacey: "Some Aspects of the Chemistry of Fluorocarbons".

PHARMACEUTICAL SOCIETY, MANCHESTER, SALFORD AND DISTRICT BRANCH (in the Council Chamber, Houldsworth Hall, Manchester), at 7.45 p.m.—Prof. H. Brindle: "Penicillin".

Friday, February 14

BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 11.30 a.m.—Annual General Meeting.

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. P. R. Masheder: "Lubrication—its Application and Control in the Textile Industry".

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. D. H. Hewitt: "Further Developments in Styrene Co-Polymers".

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Mr. L. V. Chilton, Dr. H. H. Hopkins and Mr. J. S. Preston: "Physical Optics and Technical Applications"; Dr. W. S. Stiles: "Visual Photometry, Colorimetry and Physiological Optics" (Reports on the Réunion d'Opticiens, Paris, October 1946).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. H. H. Plaskett, F.R.S.: "Astronomical Spectroscopy". Annual General Meeting.

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. G. Eyssen: "Polyvinyl Chloride and its Co-Polymers".

PAPER MAKERS' ASSOCIATION, NORTHERN DIVISION (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Dr. W. W. Barkas: "The Sorption and Swelling of Cellulose under Naturally Imposed Restraints".

TEXTILE INSTITUTE, BOLTON BRANCH (at the Municipal Technical College, Bolton), at 7.30 p.m.—Mr. F. Scholefield: "A Service by the Dyer to the Manufacturers".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. F. Ian G. Rawlins: "Natural Science and the Fine Arts".

Saturday, February 15

BIOCHEMICAL SOCIETY (at the London School of Hygiene, Keppel Street, London, W.C.1), at 11 a.m.—Symposium on "The Relation of Optical Form to Biological Activity in the Amino-Acid Series".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR LECTURER IN PHYSICS at the Leeds College of Technology—The Director of Education, Education Department, Calverley Street, Leeds 1 (February 15).

LECTURERS AND TEACHERS IN CHEMISTRY AND METALLURGY (Graduate), MECHANICAL ENGINEERING (Graduate), CIVIL AND STRUCTURAL ENGINEERING (Graduate), and AUTOMOBILE ENGINEERING, at the Chance Technical College—The Chief Education Officer, 215 High Street, Smethwick (February 15).

SENIOR LECTURER IN MATHEMATICS in the Training Department—The Warden, Goldsmiths' College, New Cross, London, S.E.14 (February 15).

LECTURER IN CHEMISTRY—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex (February 17).

ASSISTANT AGRICULTURAL ECONOMIST (male)—The Secretary and Registrar, The University, Bristol (February 18).

LECTURER (part-time) IN PSYCHOLOGY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (February 20).

LECTURER OR ASSISTANT LECTURER IN ELECTRICAL ENGINEERING—The Secretary, King's College, Strand, London, W.C.2 (February 21).

SENIOR ASSISTANT PHYSICIST IN THE DEPARTMENT OF PHYSICS APPLIED TO MEDICINE—The Dean, Middlesex Hospital Medical School, London, W.1 (February 28).

LECTURER IN GEOGRAPHY—The Registrar, The University, Manchester 13 (February 28).

CHEMIST to be trained for Spectrographic Analysis—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (February 28).

LECTURESHIP IN MATERIA MEDICA and the ROBERT POLLOK LECTURESHIP IN PHARMACOLOGY—The Secretary of the University Court, The University, Glasgow (February 28).

EDUCATIONAL PSYCHOLOGIST—The Director of Education, Education Office, College of Technology, Belfast, endorsed 'Educational Psychologist' (February 28).

DIRECTOR OF RESEARCH—The General Secretary, British Hat and Allied Felt'm kers' Research Association, 12 St. Peter's Square, Stockport, Cheshire (March 1).

LECTURERS (2) IN CHEMISTRY (one with special qualifications in Organic Chemistry, and the other in Physical Chemistry)—The Registrar, The University, Reading (March 3).

TECHNICAL OFFICER to undertake technical service and liaison visits to member firms of the Association—The Director of Research, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon (March 8).

LECTURER IN BOTANY at the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (March 10).

CHAIR OF PHYSICS—The Principal, Heriot-Watt College, Edinburgh (March 10).

OFFICIAL FELLOW AND TUTOR IN CHEMISTRY—The Principal, Jesus College, Oxford (March 15).

HARRISON CHAIR OF MECHANICAL ENGINEERING—The Registrar, The University, Liverpool (March 15).

CHAIR OF PHYSIOLOGY tenable at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 25).

CHAIR OF PHYSIOLOGY tenable at St. Bartholomew's Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 25).

CHAIR OF POLITICAL SCIENCE in Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (April 7).

ENTOMOLOGIST with a special interest in and knowledge of the coleoptera, and an ENTOMOLOGIST with a special interest in and knowledge of the hymenoptera—The Director, Imperial Institute of Entomology, 41 Queen's Gate, London, S.W.7 (June 1).

LABORATORY STEWARD FOR ELECTRICAL MEASUREMENTS LABORATORY—The Head of the School of Engineering, The Polytechnic, 309 Regent Street, London, W.1.

GRADUATE (young, female) with a degree in zoology for research in anthropometric studies—The Secretary, The University, Edmund Street, Birmingham 3.

TEACHER OF PHYSICS AND MATHEMATICS at the Doncaster Technical College—The Chief Education Officer, Education Offices, Doncaster.

LECTURERS IN MATHEMATICS, PHYSICS AND CHEMISTRY—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

LABORATORY ASSISTANTS (2, male) for work in the Medical Research Council Unit for Bacterial Chemistry—The Secretary, Unit for Bacterial Chemistry, Lister Institute, Chelsea Bridge Road, London, S.W.1.

CHEMICAL ENGINEER (graduate) for furnace research and development—The Assistant Secretary, British Coal Utilisation Research Association, 13 Grosvenor Gardens, London, S.W.1.

RESEARCH OFFICER with good qualifications in physical chemistry and with research experience, a JUNIOR RESEARCH OFFICER, and a man with the Higher National Certificate in Physics (or equivalent qualification) to assist with the development, calibration and servicing of industrial electrical instruments—The Director of Research, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

LECTURER IN APPLIED MECHANICS at the Royal Naval College, Greenwich—The Director, Education Department, Admiralty, Whitehall, London, S.W.1.

PROFESSORSHIP OF PURE AND APPLIED MATHEMATICS in the Royal University of Malta—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

ASSISTANT CONTROLLERS OF TELECOMMUNICATIONS (Engineering) and ASSISTANT CONTROLLERS OF TELECOMMUNICATIONS (Wireless) in the Telecommunications Department of the Malayan Union—The Director of Recruitment, Colonial Office, 15 Victoria Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scottish Reconstruction Committee. Bulletin No. 16: The Raw Materials of Scotland—Peat. By A. G. Clement and Robert H. S. Robertson. Pp. 6. (Glasgow: Scottish Reconstruction Committee, 1946.) 3*d*. [2211]

Department of Scientific and Industrial Research: Fuel Research Technical Paper No. 53: Smoke and its Measurement—The Correlation of Optical Density with the Nature and Quantity of Smoke from a Hand-fired Lancashire Boiler. Pp. iv + 20. (London: H.M. Stationery Office, 1946.) 6*d*. net. [2211]

Hull Bulletins of Marine Ecology. Vol. 3, No. 17: The Plankton of the North Sea in relation to its Environment, Part 1, The Hydrological Background in the Southern North Sea, 1930–37. By Dr. C. E. Lucas and K. M. Rae. Pp. 33. (Hull: University College, 1946.) 3*s*. 6*d*. [2211]

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 19: The Feeding Value of Seaweeds. By B. J. Senior, P. Collins and M. Kelly. Pp. 273–291. (Dublin: Hodges, Figgis and Co., Ltd. London: Williams and Norgate, Ltd., 1946.) 2*s*. [2210]

Royal Cancer Hospital Mechanically Sorted Punched Card Index System. Compiled by Dr. D. W. Smithers, K. M. H. Branson and Dr. H. O. Hartley. Pp. 102. (London: Royal Cancer Hospital, 1946.) [2410]

Scientific and Technical Aspects of the Control of Atomic Energy. Pp. v + 42. (London: H.M. Stationery Office; Lake Success, N.Y.: United Nations Department of Public Information, 1946.) 1*s*.; 25 cents. [2410]

Apparent Places of Fundamental Stars, 1947: containing the 1535 Stars in the Third Fundamental Catalogue (FK3) of the Berliner Jahrbuch. (Published by order of the Lords Commissioners of the Admiralty.) Pp. xxxii + 538. (London: H.M. Stationery Office, 1946.) 42*s*. net. [2810]

Scientific Proceedings of the Royal Dublin Society. Vol. 24 (N.S.), No. 17: On a Recent Bogflow in Meenacharvy Townland, Co. Donegal. By D. W. Bishop and G. F. Mitchell. Pp. 151–156. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1946.) 1*s*. [2810]

Universities Quarterly. Vol. 1, No. 1, November. Pp. 112. (London: Turnstile Press, Ltd., 1946.) 5*s*. [2810]

Russian Studies. Edited by Dr. Louis Segal. (Published bi-monthly.) Vol. 1, No. 1. Pp. 24. (London: Collet's Holdings, Ltd., 1946.) 1*s*. [2910]

You and Your Children: B.B.C. Talks by a Woman Medical Psychologist. Pp. 32. (London: H.M. Stationery Office, 1946.) 6*d*. [2910]

Ministry of Agriculture and Fisheries. Bulletin No. 133: Apples and Pears. Pp. vi + 119 + 17 plates. (London: H.M. Stationery Office, 1946.) 2*s*. 6*d*. net. [3010]

Other Countries

Annals of the Observatory of Lund. No. 8: Latitude and Longitude Determinations in Eastern Turkistan and Northern Tibet derived from Astronomical Observations. By Nils Amboit. (Reports from the Scientific Expedition to the North-Western Provinces of China under the Leadership of Dr. Sven Hedin: The Sino-Swedish Expedition, Publication 6, II. Geodesy, 1.) Pp. 143. No. 9: A Study of External Galaxies with special regard to the Distribution Problem; Researches based on a Catalogue of 4666 Galaxies. By Anders Reiz. Pp. 84 + C96. No. 10: A Morphological Investigation of some Near Galaxies with regard to the Lengths and the Form of their Arms, their Inclinations and their Symmetry Properties. By Carl-Gustav Danver. Pp. 192 (8 plates). (Lund: Astronomiska Observatorium, 1938–1942.) [3010]

Development and Welfare in the West Indies. Bulletin No. 22: The Fisheries of Cayman Islands. Report by Dr. Ernest F. Thompson. Pp. 34. (Bridgetown: Advocate Co., Ltd., 1946.) 10 cents. [3110]

National Research Council of Canada: Research Plans and Publications Section. RP.12/45: Short Circuit and High Voltage Testing Laboratory of the Swedish General Electric Company (ASEA) at Ludvika, Sweden, 1934. By R. Kempe. Translated from *Revue générale de l'Electricité* by R. Ruedy. Pp. ii + 12. RP. 13/45: High Voltage and Heavy Current Research Laboratories of the Maschinenfabrik Oerlikon near Zurich, 1941. By H. Puppikofer. Translated from *Association Suisse des Electriciens Bulletin*, with a Note on the Brown Boveri Voltage Laboratory by R. Ruedy. Pp. ii + 13. RP. 14/45: High Voltage Equipment in the Ampere Laboratory of the General Electro-Ceramic Society at Ivry, France. Translated from *Revue générale de l'Electricité* by R. Ruedy. Pp. 26. (Ottawa: National Research Council, 1945.) [3110]